ALLEN TEST

PROGRAMMED TRAINING COURSE

53-500 SERIES EPA ANALYZER

Testproducts Division Kalamazoo, Michigan 49007 • Mississauga, Ontario

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FOREWORD

Thank you for placing your confidence in Allen Testproducts. Your Allen Testproducts Test Analyzer System (TAS) is engineered to meet or exceed all design and performance criteria for an automated tamper-resistant TAS.

Your Allen TAS module can be used to test and repair vehicles subject to your state's Inspection & Maintenance (I&M) Program. It features simple to operate computer directed modes (Michigan Emission Inspection, Inspector Training, Smart or Network Diagnostics, and TAS Service), and a versatile operator directed mode (Manual Operation). To expand testing capability, the TAS module can be electronically interfaced (networked) to communicate with a Smart Engine Analyzer (SEA) module. This makes performance testing of all under hood systems possible.

Your Allen TAS unit monitors test procedures, exhaust sample and rpm quality, data storage, state required calibration and maintenance, malfunctions, and unit tampering to guarantee accurate vehicle certification tests. If the TAS module monitors a problem, an operational lookout can occur and could require a service call if the operator is not authorized to reinstate the unit. Operate and maintain your TAS properly to prevent unnecessary down time.

Your Allen unit is certified as a "High Thru-Put" analyzer. This means your TAS unit is capable of testing a minimum of 5 vehicles per hour with 2 operators. This "High Thru-Put" capability is a definite plus to you, the Allen customer.

Your Allen TAS unit has the option of measuring 4 exhaust gases and the same state-of-theart innovations in artificial intelligence as our patented Smart Scope.

Allen Testproducts is unequaled in their line of Smart products. As a member of a growing elite group of Allen customers, Allen Testproducts is dedicated to making you a successful, satisfied user of their Smart products. If you ever need assistance, contact your local Allen representative or office.

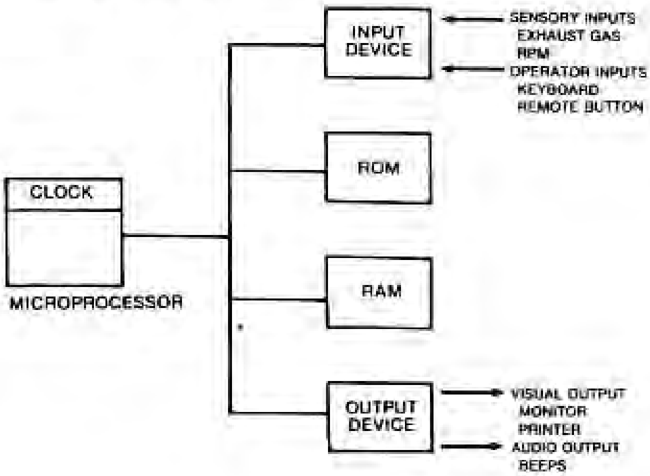
THEORY OF OPERATION

COMPUTERS

The TAS unit is actually a computer controlled exhaust emission analyzer. Electronic computers have been in use since 1945 and their operating principle remains basically the same.

A microcomputer is made up of five basic parts:

1. A microprocessor (CPU)
2. A read-only memory (ROM)
3. A random access memory (RAM)
4. An input device.
5. An output device.



Microprocessor

The microprocessor is also called a Central Processing Unit (CPU). It ties all the parts of the computer together and coordinates the movement of data from one part to another. All data calculation and decision making is performed by the microprocessor.

Read Only Memory

The ROM is a nonerasable memory component loaded with a program during its manufacturing process. It contains a whole library of data about program instructions and parameters. When "read" the ROM gives out stored data. The ROM cannot be "written to" (pickup new data) during computer use. Many micro computers use a programmable read - only memory (PROM) instead of a ROM. The main difference is that a PROM is loaded after is is manufactured. One style of PROM is erasable using special equipment and is called an E-PROM. E-PROMS may be reprogrammed and reused.

Random Access Memory

The RAM is a volatile (erasable) memory component. It acts as a temporary data store while the computer is in operation. It maintains its memory as long as power is applied to it. A battery backup system may be used to prevent unwanted memory loss should a power failure occur. A RAM library may be read from or written to during computer operation.

Input Device

The input device translates information from the operator or sensory system into digital data that the CPU can understand. The TAS unit receives information from the keyboard, remote button, tachometer pickup, infrared bench, and oxygen sensor (if equipped).

Output Device

The TAS output device converts CPU digital data into visual/audio information for communication with the operator. Visual information is displayed on the monitor screen or printed by the printer. Audible beeps are used to notify the operator of keyboard selections and signals the end of the warm-up sequence.

EXHAUST ANALYSIS

Understanding the nature of combustion is the key to analyzing engine performance using exhaust gases. Quality combustion depends on:

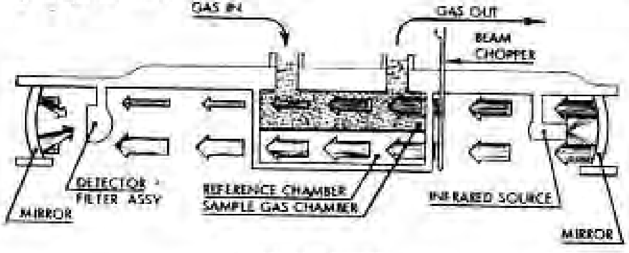
1. Induction of an air-fuel mixture that is of the proper ratio and quantity.
2. Mechanical integrity that promotes coordination of components and good sealing during compression and expansion.
3. Ignition that is correctly timed and develops good spark intensity and duration.

In the laboratory, perfect combustion changes the ingredients, hydrocarbon fuel (HC) and air (N_2 and O_2) into the desirable byproducts, carbon dioxide (CO_2) and water (H_2O). However, in the automobile, varying amounts of undesirable byproducts; carbon monoxide (CO), oxides of nitrogen (NOx), and particulates (soot), are also formed.

Typicially the engine exhaust contains byproducts plus unburned ingredients. The analyzer detects and reports the level of the each exhaust component of interest (CO, HC, CO_2, O_2).

INFRARED BENCH

The optical bench assembly is the heart of the analyzer system. It contains an infrared energy source, a chopper wheel and gas chambers, and a detector/amplifier and a signal processor.



OPTICAL BENCH

In operation, the system compares the radiant energy received at the end of two identical optical paths. One optical path shines through the sample gas chamber— the other through the reference gas chamber. The difference in energy level is used to measure the concentration (ppm or % by volume) of the sample gas. The energy is sensed by a detector. The detector output signal is processed and drives the digital displays (CO, HC, and CO_2).

Infrared Energy Source

The infrared source is a heater element which emits radiant energy toward a concave mirror. This reflects parallel (and equal energy) beams through both gas chambers.

Chopper Wheel and Gas Chambers

The beams are interrupted by a chopper wheel to create an alternate on-off pulse. The beams then pass through the sample and reference gas chambers. Energy through the reference chamber, is basically unchanged and provides a standard for comparison. Energy through the sample chamber, is reduced in exact proportion to the concentration of the gas. The optical system response over the range of calibration is in agreement with the "Lambert-Beer" law of infrared light absorption by gases.

Detector/Amplifier

After passing through the two chambers the radiant beams are combined, reflected, and focused by a second mirror. The beam then shines through an optical filter and onto the detector.

The optical filter tunes the system to see only the energy in the absorption band of the individual gas being sampled. The filter eliminates any stray energy. This stray energy could otherwise add an undesirable level of "noise" (unwanted signal) to the system if that energy were permitted to strike the detector.

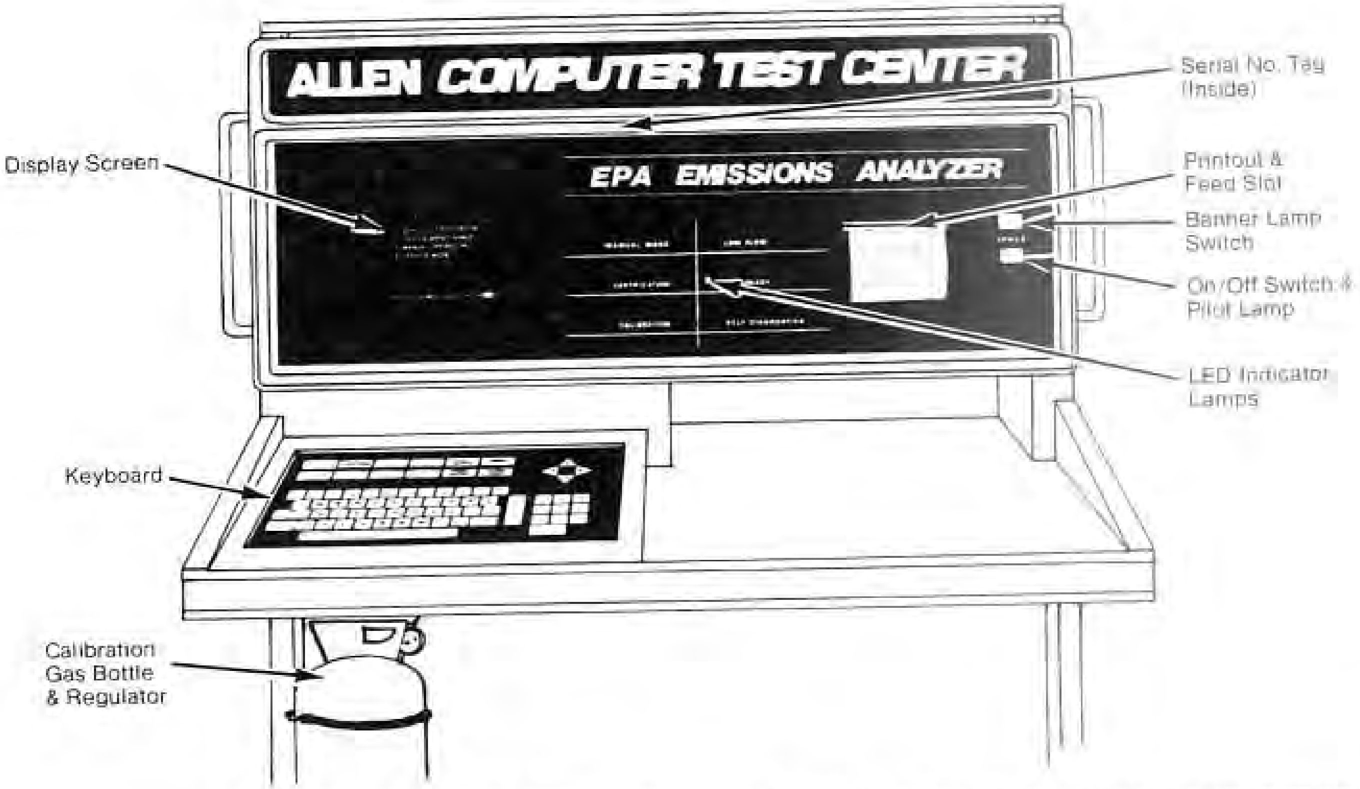
The detector converts the remaining optical energy into an electrical signal. The signal is further amplified and demodulated before it drives the appropriate digital display. Thus, infrared energy is used to measure CO, HC, and CO_2.

OXYGEN SENSOR

Allen's exhaust analyzers measure the oxygen (O_2) content of the vehicle exhaust with an O_2 sensor. It is located in the outlet stream of the infrared bench. The gas sample is measured for carbon monoxide (CO), hydrocarbons (HC), and carbon dioxide (CO_2) in the infrared bench, then it goes to the O_2 sensor.

Internally the sensor works like a battery, developing voltage from dissimilar electrode materials in a water base electrolyte. It produces a small current proportional to the amount of oxygen surrounding its sensing surface. This electrical signal is amplified and modified to operate the digital readout for oxygen.

GETTING TO KNOW YOUR TAS ANALYZER



DISPLAY SCREEN: Shows all test procedures, instructions, input information, and test results.

KEYBOARD: Allows the operator to communicate with the TAS Unit.

CALIBRATION GAS & REGULATOR: Required for periodic calibration of the TAS Unit. The regulator assembly controls gas flow during calibration. (Regulator should be set to 15 PSI).

SERIAL NUMBER TAG: Located behind front panel.

PRINTOUT & FEED SLOT: Printed Vehicle Inspection Report (VIR) comes out here.

BANNER LAMP SWITCH: Lights the fluorescent banner lamp when the TAS is off.

ON/OFF SWITCH AND PILOT LAMP: Push the button once to turn the TAS on or off. The pilot lamp is in the button—it lights when the TAS is on.

LED INDICATOR LAMPS: Indicates the analyzer's operating status.

Manual Mode: Lights during Manual Operation mode. Manual Operation, displays gas and rpm.

Certification: Lights when the mode used for vehicle certification is activated.

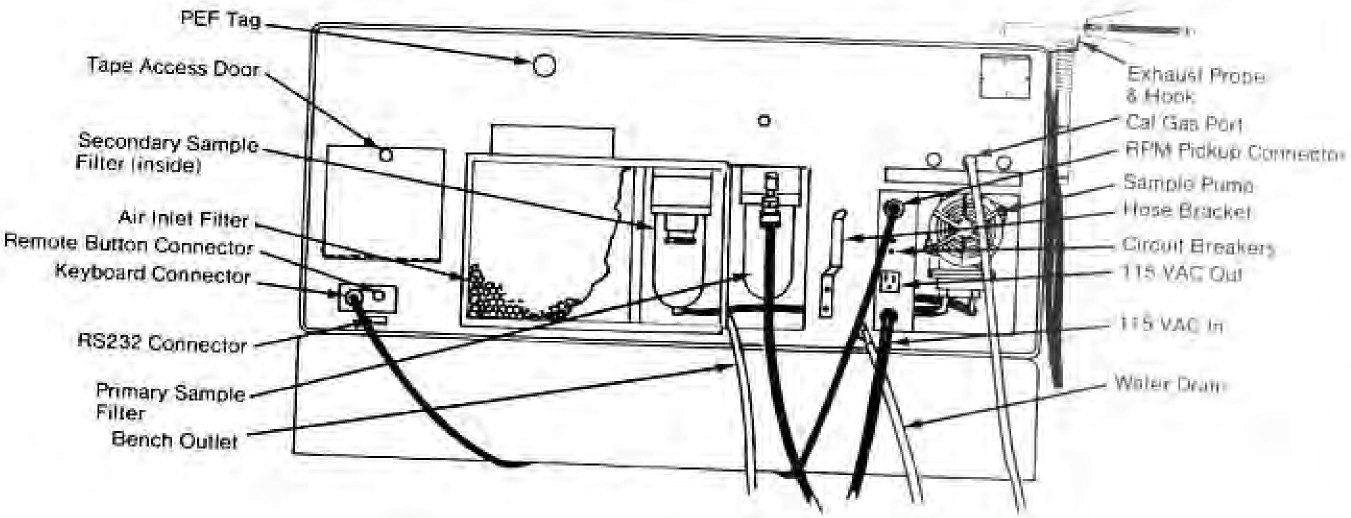
Calibration: Lights during a gas calibration sequence.

Low Flow: Lights to indicate a flow restriction in the sample system.

Unit Ready: Lights when the TAS is fully operational.

Self Diagnostics: Lights during the self-diagnostics sequence.

GETTING TO KNOW YOUR TAS ANALYZER



PEF TAG: Identifies the propane equivalency factor assigned to the TAS infrared bench.

TAPE ACCESS DOOR: Access for the tape drive door.

SECONDARY SAMPLE FILTER: Removes water from the exhaust sample.

AIR INLET FILTER: Air inlet for the TAS cooling system. Must be removed to access the Secondary Filter (water separator).

REMOTE BUTTON CONNECTOR: The cable for the remote continue/print button attaches to this threaded connector.

KEYBOARD CONNECTOR: The cable for the keyboard attaches to this threaded connector.

RS232 CONNECTOR: To electronically interface the TAS to an SEA; a cable is attached to the RS232 connector on both units.

PRIMARY SAMPLE FILTER: Cleans the exhaust sample and protects the infrared bench.

BENCH OUTLET: Exit port for the infrared sample system. This port must be unrestricted to protect the infrared bench.

EXHAUST PROBE AND HOOK: The exhaust sample is drawn through the probe and hose. The hook is for storage.

CAL GAS PORT: The hose from the calibration gas bottle attaches here.

RPM PICKUP CONNECTOR: The rpm pickup cable attaches to this connector.

SAMPLE PUMP: The dry side pumps the exhaust sample from the vehicle through the infrared bench. Water is removed from the sample with the wet side.

HOSE BRACKET: Bracket for hanging hoses or electrical cables.

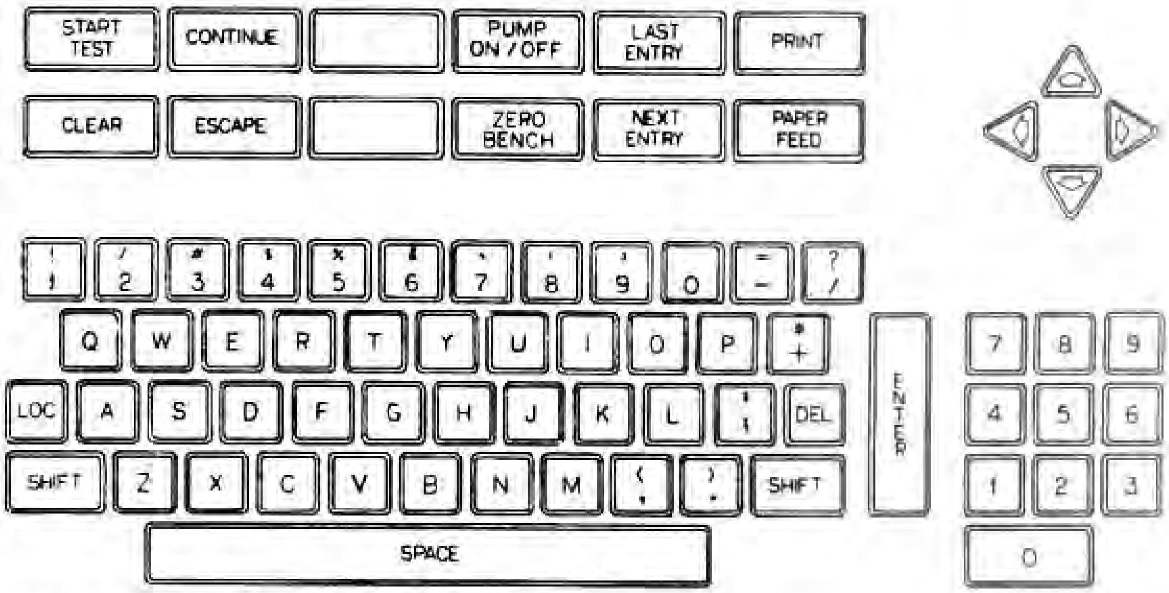
CIRCUIT BREAKERS: Opens the electrical circuit to protect the unit from excessive current draw. For no pilot light, check the wall plug and press the breakers to reset.

115 VAC OUT: AC Power receptacle for optional equipment.

115 VAC IN: AC Power supply cord for the unit. See Power Requirements.

WATER DRAIN: Outlet port for the water separator system. This port must be unrestricted to protect the infrared bench.

TAS KEYBOARD FEATURES



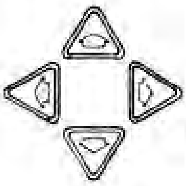
TYPEWRITER & STATISTICAL KEYS

The Alpha keys enter uppercase letters when the Shift key is released. Lower-case letters and special characters are available for Name Entry screens (Customer, Business, etc.) by pressing or locking the Shift key first.

Numbers are entered by using the top row or 10-key number pad.

SHIFT	Shifts letters from uppercase to lowercase and controls dual purpose keys.
LOC	Locks the Shift key in Shift Up position. Press **LOC** again to release.
DEL	Deletes last character entered.
SPACE	Inserts space between characters.

SPECIAL FUNCTION KEYS

ENTER	Stores the data typed in and proceeds to the next step, if data is proper.
	Moves the cursor one space for each key stroke, in direction indicated on key.
START TEST	Signals TAS that the Data Entry screens are accurately completed, and to start the vehicle test.

CLEAR	Clears all characters on the entry line.
CONTINUE	Signals TAS to proceed to the next step.
ESCAPE	Exits the current routine (when activated) and returns to the Set-up screen.
PUMP ON / OFF	Allows the pump to be turned off between tests.
ZERO BENCH	Adjust the bench readings to zero on room air.
LAST ENTRY	Provides backward reviewing of the Data Entry screens, once data is entered on current screen.
NEXT ENTRY	Provides forward "scrolling" of the Data Entry screens, to return to origin.
PRINT	Provides printing (if activated) of Test Result or Malfunction screens.
PAPER FEED	Activates the printer to feed out paper (1/4 inch) each time the key is pressed.
	Used to **CONTINUE** or **PRINT** when the keyboard cannot be reached.

OPERATING PRELIMINARY

POWER REQUIREMENTS

Before installing your Allen analyzer, check the quality of the shop's power distribution system. Recent studies have shown that up to 65% of all existing buildings have A/C power distribution problems.

Proper A/C power distribution is the most important factor to ensure a high level of reliability with any type of electronic equipment. Allen computerized analyzers are equipped with inline filters designed to withstand voltage changes far in excess of normal. Unfortunately, reversed polarity wiring, low line voltage, and inadequate grounding (high impedance) are shop problems that must be checked and corrected on site.

The wall receptacle must meet the following power requirements:

1. The receptacle must be wired with the proper polarity.

   The neutral (white) and hot (black) wires must be properly connected at the fuse panel and receptacle.

2. The available voltage at the receptacle must be 60 Hz and 115 VAC ± 10% when the equipment is on and the line is under load.

   A "dedicated" power supply circuit might be needed if a shared circuit, cannot provide 104 VAC minimum.

3. The receptacle must have a good "earth", or low impedance ground.

   An "Isolated Ground Receptacle" (orange color) might be needed to satisfy the grounding requirement. This provides a "dedicated" ground path that segregates the shop's common ground system from the analyzer. Common ground systems can act as a giant antenna and conduct electrical noise (transient signals induced by other equipment) into the analyzer.

To protect unit reliability, make sure your shop's power distribution system is modernized to meet the power requirements.

Ask an Allen Service Technician to check your shop power.

THE PRINTER

The printer will provide copies of a vehicle inspection or diagnostic report, manual operation, and the result of some TAS service procedures.

Change the printer paper (see Analyzer Maintenance section) when a red border mark appears on the paper. To extend the life of the printer head, avoid operating the printer without paper and using paper that does not meet or exceed the surface smoothness specification for Allen quality paper (P/N 42901).

DAILY WARM-UP PROCEDURE

The analyzer must be cycled off/on once each day to initiate the analyzer's self diagnostic routine. Do not turn off the power when Cassette in Operation is displayed.

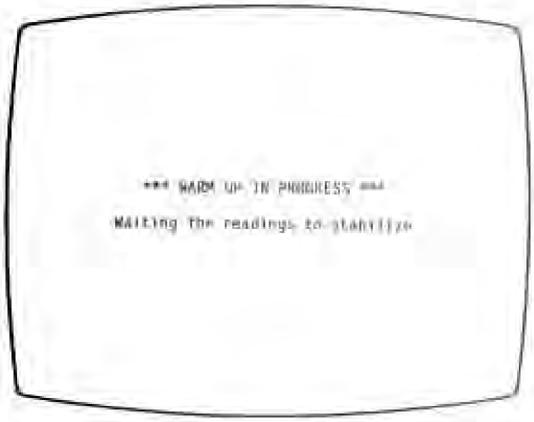
- Hang the exhaust probe on TAS hook or suitable environment 4 feet above the shop floor.
- Press the red power button once to turn the TAS unit on and start Warm-up.

The Warm-up sequence automatically progresses through four stages until the Set-up screen appears for operating mode selection.

If the **Escape** key is selected during Warm-up, the routine will advance to the Set-up screen and display Lockout. When this occurs, only the Service mode is available. Turn the power off, then on and allow the Warm-up to finish.

When a fault is detected the routine will halt and display a Fault prompt, or divert to the Setup screen. The modes available and prompts displayed on the Setup screen depends on the nature of the fault.

WARM-UP SCREEN



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*** WARM UP IN PROGRESS ***

Waiting the readings to stabilize
```

Stage 1, .25 minutes, the LED indicator lamps blink while the TAS electrical circuits are checked.

Stage 2, 1.75 minutes, Cassette in Operation XXXX appears while the tape system is checked and the software program is loaded into the computer RAM.

Stage 3, 5-20 minutes, Cassette in Operation XXXX goes away and Warm-up in Progress remains. The bench temperature and gas readings are checked for stability, while air flow through the Fresh Air Port is monitored. This stage will take less than 20 minutes or the routine will advance to the Set-up screen and a Lockout occurs.

Stage 4, 1 minute, Zeroing Bench appears. The zero setting of the infrared bench is adjusted, and the air flow through the Exhaust Probe Port is checked.

Stage 5, the Set-up screen is displayed for operating mode selection.

Warm-up Prompts

Fault and Operating Status prompts can be displayed during Warm-up. The following glossary explains each prompt.

CASSETTE IN OPERATION: Appears when the analyzer is reading from, or writing to the data tape.

INSTALL BACKUP PROGRAM PRESS CONTINUE WHEN READY: Indicates the TAS is having trouble reading, or writing to the data tape. Restart Warm-up or clean the recorder head and install another program tape.

UNIT TAMPERED/TAPE NOT CHANGED: Appears during a tape change and indicates the cassette door was opened but the tape was not changed. Repeat the procedure correctly.

TAPE DOOR OPEN: Indicates the tape drive door is open. Close the tape door.

TAPE IN BACKWARDS: Indicates the tape is installed wrong. Side "B" must engage the tape drive splines first when the tape drive door is closed.

TAPE WRITE PROTECTED: Indicates that the erase prevention tabs on the cassette tape are gone or in the wrong position, thus TAS cannot record. Install another new tape if the tabs are gone.

TAPE READ/WRITE ERROR: Can appear during a tape change. Indicates data cannot be stored onto or recovered from the tape. Clean the recorder head and install the correct new tape (blank or preprogrammed).

BAD TAPE: Appears during a tape test if the tape is defective. Clean the tape recorder head and install the correct new tape (blank or pre-programmed). See PTC section 4—TAS Service mode, New Tape—item 7.

INADEQUATE FLOW THROUGH BENCH: Appears during Warm-up before zeroing the bench. Indicates a restiction between the fresh air port and exhaust pump (dry pump) inlet, or pump trouble. Also sets Bad Flow and Unstable Channels on the malfunction screen. Repair the fault and repeat Warm-up to clear the malfunction.

WAITING FOR TEMPERATURE TO STABILIZE: Indicates the bench temperature has not reached operating status. A dirty air inlet filter for the cooling system will prolong Warm-up.

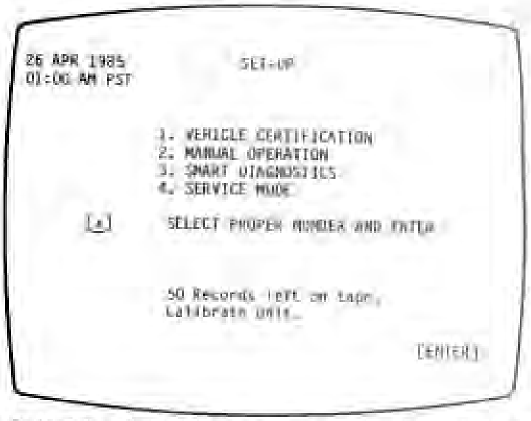
WAITING FOR READINGS TO STABILIZE: Indicates the bench readings have not reached operating status.

ZEROING BENCH: Appears (60 sec.) while the bench zero setting is adjusted and the sample system flow is checked. Low Flow will not cause a lockout, but will set a message on the malfunction screen and stop progress during a certification test. See PTC section 4—TAS Service mode, Unit Malfunctions—item 2.

OPERATING MODE SELECTION

Once the Warm-up sequence is completed, the Set-up screen is displayed for operating mode selection. The Set-up screen displays all operating modes and no fault prompts, when full operating status is available.

SET-UP SCREEN—full status



```
26 APR 1985                SET-UP
01:06 AM PST

               1. VEHICLE CERTIFICATION
               2. MANUAL OPERATION
               3. SMART DIAGNOSTICS
               4. SERVICE MODE

      [▪]       SELECT PROPER NUMBER AND ENTER


                50 Records left on tape,
                Calibrate unit.

                                      [ENTER]
```

- Select the desired operating mode, then press **ENTER**.
- For operating instructions, go to the appropriate PTC section for the mode selected.

After 45 minutes of stand-by, the screen and pump turns off automatically. Power to the rest of the unit remains on. This keeps the unit warm for instant operation, and extends pump and monitor life.

- Press **PUMP OFF**, to turn the pump off manually.
- Press any key to reactivate the screen and pump again.

Operating Mode Glossary

The following glossary explains each operating mode.

MODES:

1—VEHICLE CERTIFICATION TEST : For state emission inspection programs. Refer to PTC, section 1.

2—MANUAL OPERATION TEST : Displays exhaust gas and rpm for manual testing. Refer to PTC, section 2.

3—SMART OR NETWORK DIAGNOSTICS : For vehicle performance tests. Provides repair and adjustment recommendations. Refer to PTC, section 3.

4—ANALYZER SERVICE PROCEDURES : Used for delivery initialization, required periodic services, software updates, and to identify and correct faults. Refer to PTC, section 4.

OPERATING STATUS—TAS SELF TESTS

The TAS computer monitors Warm-up, operating procedures, exhaust sample and rpm quality, the data storage system, state required calibration and maintenance, unit malfunctions, and security for protected systems; to evaluate the analyzer's operating status.

When all factors are normal, all operating modes and no fault prompts appear on the Set-up screen.

When the time for a calibration or tape change approaches, a Maintenance Reminder prompt is displayed on the Set-up screen.

When a fault is monitored, the TAS can:

1. Abort the current routine and divert to the Set-up or Service Menu screens.
2. Display Lockout on the Set-up screen.

   When a fault affects I&M program compliance, mode 1 is locked out. All other modes are available to use.

   When a fault affects all vehicle test modes, only the TAS Service mode is available.

3. Halt progress during a routine until the fault is corrected.
4. Display a fault prompt.
5. Trigger a message on the malfunction screen.

Faults are caused by:

1. Not following procedures carefully.
2. Bypassing required periodic services.
3. Tampering with protected TAS systems.
4. TAS malfunctions.
5. Abnormalities in the exhaust sample or rpm quality.

SET-UP SCREEN PROMPTS

Based on the result of the analyzer's self tests, the Set-up screen can display Maintenance Reminders or Fault prompts.

Maintenance Reminder Prompts

The following glossary explains each prompt.

50 RECORDS LEFT ON TAPE: Appears when only 50 unused record places are left on the tape. The tape must be changed by an authorized person before its full (0 records left) and a lockout occurs (mode 1). The message, Change Tape to Disable Lockout appears when the tape is full. See PTC section 4— TAS Service mode, New Tape—item 7; to perform a tape change.

CALIBRATE UNIT: Appears 144 hours (6 days) after the last calibration. Every 168 hours (7 days) a Gas Calibration and Leak Test is required by the state. The unit must be calibrated (by an authorized person) before the 168 hour time limit expires and a lockout (mode 1) occurs. If the time limit expires during a Certification test, the lockout occurs after the test. See PTC section 4—TAS Service mode, Leak Calibration Test—item 1.

Fault Prompts

Use following glossary to explain each prompt.

LOCKOUT: Indicates only partial operating status is available because a fault is detected. The fault will set a message on the Unit Malfunction screen. Refer to PTC section 4—TAS Service mode, Unit Malfunctions—item 2, to disable the lockout.

CALIBRATE UNIT TO DISABLE LOCKOUT: Appears for expired calibration, zero over range, zero under range, and span or cal failure faults. Calibrate the unit. Refer to PTC section 4—TAS Service mode, Leak Calibration Test—item 1.

CHANGE TAPE TO DISABLE LOCKOUT: Appears when the tape is full. Change the tape. Refer to PTC section 4—TAS Service mode, New Tape—item 7; to perform a tape change.

O_2 MALFUNCTION: Indicates a fault in the oxygen sensor or circuit (if equipped). Try zeroing the bench or a gas calibration to clear this fault. Refer to PTC section 4—TAS Service mode, Leak Calibration Test—item 1.

BAD CLOCK: Indicates a fault in the TAS clock that times the calibration cycle. See PTC section 4—TAS Service mode, Unit Malfunctions—item 2.

DATA ENTRY ERROR PROMPTS

The following fault prompts can occur when completing Data Entry screens.

PLEASE ENTER DATA: Appears if the operator presses **ENTER** before selecting any required data. Select requested data.

INVALID ENTRY—TRY AGAIN: Appears if the operator selects unacceptable data for that screen. Select proper alphanumeric characters.

TOO FEW CHARACTERS HAVE BEEN ENTERED: Appears if the operator presses **ENTER** before selecting the minimum required data.

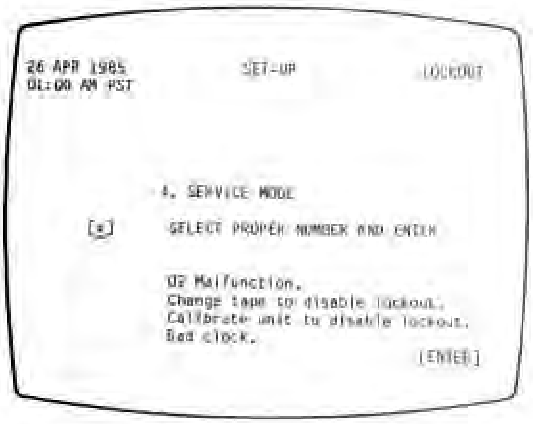
THE FIRST CHARACTER MUST BE A LETTER: An alpha character must be entered into the first character position.

INVALID ACCESS CODE: Appears if an unacceptable code is entered. Enter the proper code. Refer to PTC section 4—TAS Service mode; to identify or change your access code.

SET-UP SCREEN LOCKOUTS

A lockout of just the Certification Test (mode 1), or all vehicle tests (modes 1, 2, and 3) can occur depending on the nature of the fault.

SET-UP SCREEN—partial status/lockout



```
26 APR 1985                SET-UP                 LOCKOUT
01:00 AM PST



              4. SERVICE MODE

      [■]      SELECT PROPER NUMBER AND ENTER

               O2 Malfunction.
               Change tape to disable lockout.
               Calibrate unit to disable lockout.
               Bad clock.
                                              [ENTER]
```

Some lockouts can be reset by an "on site" employee, and others require an Allen or State person to comply with the I&M program.

Usually lockouts appear with other prompts. However, a lockout can occur without any screen prompts to identify the fault or recommend the next action. When this occurs, refer to PTC section 4—TAS Service mode, Unit Malfunctions—item 2; to identify and correct the fault.

DAILY SHUT DOWN PROCEDURE

Before shut down, use the following procedure to ensure the sample system is purged and stabilized.

1. Remove the probe from the vehicle tailpipe.
2. Operate the TAS for 4-5 minutes with the pump on, then turn off the power.

SECTION 1
VEHICLE CERTIFICATION MODE

Section one covers the operation of the Vehicle Certification mode. This mode is used to test vehicles subject to your state's Inspection and Maintenance (I&M) program.

A Certification test is easy to perform because the analyzer will:

1. Direct the operator's tasks with screen prompts.
2. Select the proper emission category for the vehicle.
3. Monitor the exhaust gas and rpm during testing.
4. Evaluate the test data for conformity to the I & M program rules.
5. Display, print and record the test result (i.e. Invalid, Failed, Passed).

SPECIAL FUNCTION KEYS—status

The **Zero Bench** and **Pump On/Off** keys are deactivated during the Certification test.

The **Escape** key is activated, after completing the access code screen, to exit the test and return to the Set-up screen.

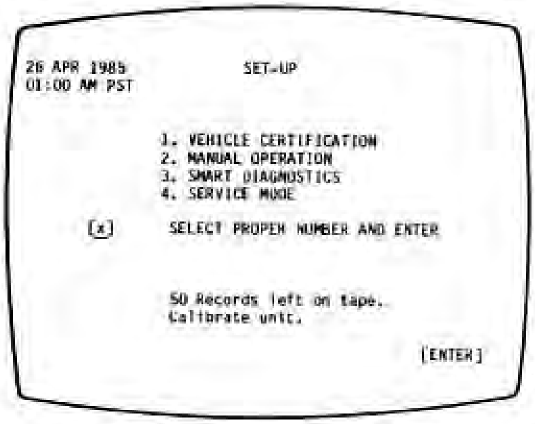
To erase entries, press **Clear** or **Delete**. To review entries, press **Last Entry** or **Next Entry**. Data must be selected, on the current screen, for the review keys to work.

Use the **Cursor** or **Alphanumeric** keys to make a selection on the Data Entry screens.

USING THE CERTIFICATION TEST MODE

To provide quick user friendly instructions, only the primary use screen prompts are explained in the following step-by-step procedures. Instructions for secondary use and fault/help prompts are explained at the end of this PTC section.

- Complete the daily Warm-up procedure to display the Set-up screen for operating mode selection.



```
26 APR 1985                SET-UP
01:00 AM PST

                   1. VEHICLE CERTIFICATION
                   2. MANUAL OPERATION
                   3. SMART DIAGNOSTICS
                   4. SERVICE MODE

        [x]         SELECT PROPER NUMBER AND ENTER


                    50 Records left on tape.
                    Calibrate unit.

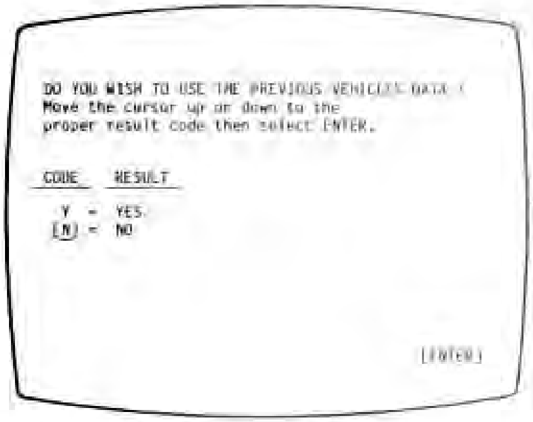
                                              [ENTER]
```

- Press **1**, then **ENTER**; to select the Certification Test mode from the Set-up screen.

The Cassette in Operation message is briefly displayed when a tape identification check is required. This step occurs if, for example, the tape was recently removed to clean the tape recorder head. If the tape check fails, a "lockout" of the Vehicle Certification Test mode occurs. Further progress is rejected until the tape check passes. The procedure aborts to the Set-up screen. Repair the tape problem and try again. Refer to PTC section 4—TAS Service mode, Unit Malfunction—item 2, Cassette Tamper or Wrong Cassette.

Vehicle Certification Test Screens

1. PREVIOUS DATA SCREEN



```
DO YOU WISH TO USE THE PREVIOUS VEHICLE'S DATA ?
Move the cursor up or down to the
proper result code then select ENTER.

 CODE    RESULT

  Y  =  YES
 [N] =  NO

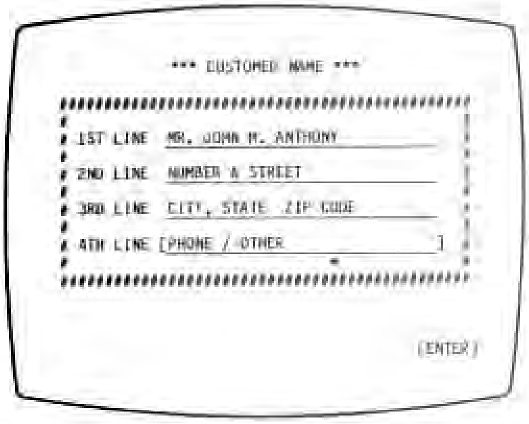


                                          [ENTER]
```

This step precedes the Customer Name screen and eliminates reselecting data for consecutive tests to the same vehicle. The data from the last test is saved and recalled during the next test.

- To receive preselected Data Entry screens; select **Y** (yes), using the **Cursor** keys, then press **ENTER**.
- To manually select all Data Entry screens; select **N** (no), using the **Cursor** keys, then press **ENTER**.

2. CUSTOMER NAME SCREEN



```
               *** CUSTOMER NAME ***

#################################################
#                                               #
# 1ST LINE  MR. JOHN M. ANTHONY                 #
#                                               #
# 2ND LINE  NUMBER & STREET                     #
#                                               #
# 3RD LINE  CITY, STATE  ZIP CODE               #
#                                               #
# 4TH LINE [PHONE / OTHER                    ]  #
#                                               #
#################################################

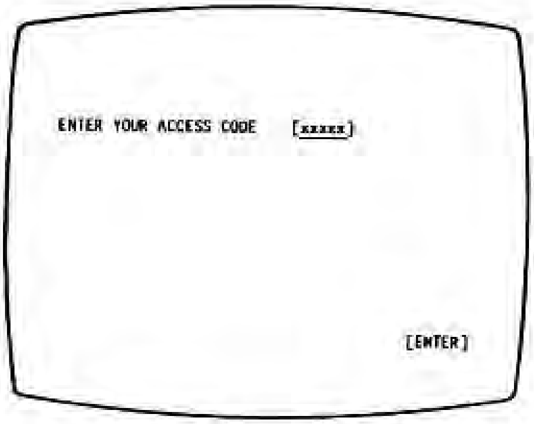
                                          [ENTER]
```

This screen information will appear on the printout.

- Type the customer's name into the first line. When correct, press **ENTER**; to advance the to the next line.
- Repeat this procedure with desired data for lines 2, 3, and 4.

- To bypass the Customer Name screen; press **ENTER** for each blank line.

3. ACCESS CODE SCREEN

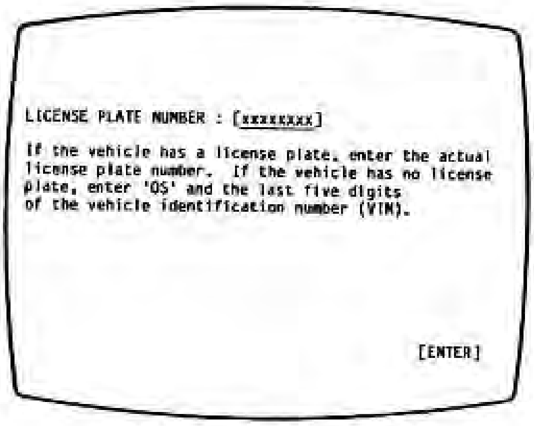


```
ENTER YOUR ACCESS CODE   [xxxxx]

                                        [ENTER]
```

- Type in your access code, then press **ENTER**.

4. LICENSE PLATE NUMBER SCREEN



```
LICENSE PLATE NUMBER : [xxxxxxxx]

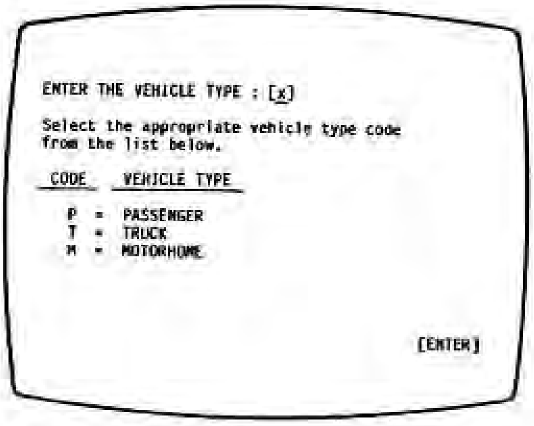
If the vehicle has a license plate, enter the actual
license plate number.  If the vehicle has no license
plate, enter 'OS' and the last five digits
of the vehicle identification number (VIN).

                                        [ENTER]
```

- Type in the vehicle license plate number, then press **ENTER**.

If no license number is available, type in **O S** plus the last five digits of the Vehicle Identification Number (VIN), then press **ENTER**.

5. VEHICLE TYPE SCREEN



```
ENTER THE VEHICLE TYPE : [x]

Select the appropriate vehicle type code
from the list below.

 CODE    VEHICLE TYPE

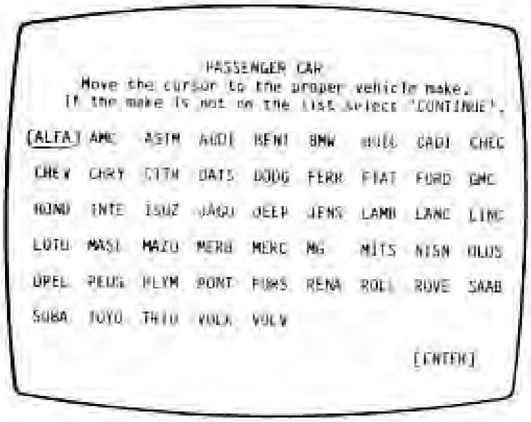
   P  =  PASSENGER
   T  =  TRUCK
   M  =  MOTORHOME

                                        [ENTER]
```

- Type in **P**, **T**, or **M**, then press **ENTER**; to identify the vehicle type.

If **T** or **M** is selected, complete steps 6B1 and 6B2 next.

6A VEHICLE MAKE SCREEN



```
                   PASSENGER CAR
      Move the cursor to the proper vehicle make.
   If the make is not on the list select 'CONTINUE'.

[ALFA] AMC  ASTN AUDI BENT BMW  BUIC CADI CHEC

CHEV  CHRY  CITN DATS DODG FERR FIAT FORD GMC

HOND  INTE  ISUZ JAGU JEEP JENS LAMB LANC LINC

LOTU  MASE  MAZD MERB MERC MG   MITS NISN OLDS

OPEL  PEUG  PLYM PONT PORS RENA ROLL ROVE SAAB

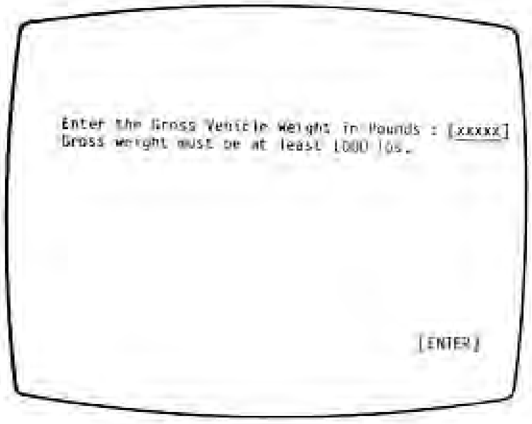
SUBA  TOYO  TRIU VOLK VOLV

                                        [ENTER]
```

- Use the **Cursor** keys to highlight the appropriate vehicle make, then press **ENTER**.

If the vehicle make is not listed, press **CONTINUE** and complete the Unlisted Vehicle screen.

6B1 VEHICLE WEIGHT SCREEN



```
Enter the Gross Vehicle Weight in Pounds : [xxxxx]
Gross weight must be at least 1000 lbs.

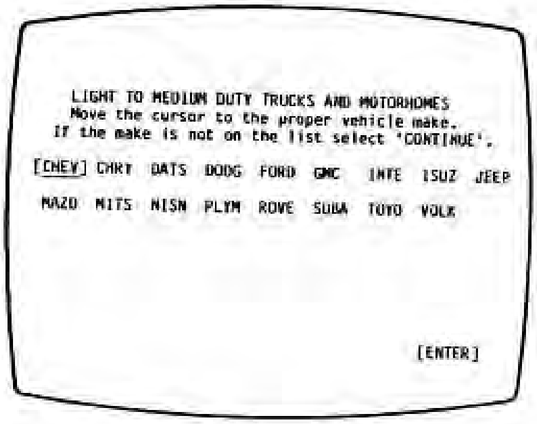
                                        [ENTER]
```

This screen appears if **T** (truck) or **M** (motor home) was entered for the vehicle type.

- Type in gross vehicle weight, then press **ENTER**.

The GVW can be found on a data tag attached to the driver's door jam, inside the glove box, or outside driver's door on commercial trucks.

6B2 TRUCK MAKE SCREEN



```
LIGHT TO MEDIUM DUTY TRUCKS AND MOTORHOMES
Move the cursor to the proper vehicle make.
If the make is not on the list select 'CONTINUE'.

[CHEV] CHRY  DATS  DODG  FORD  GMC   INTE  ISUZ  JEEP

MAZD  MITS  NISN  PLYM  ROVE  SUBA  TOYO  VOLK

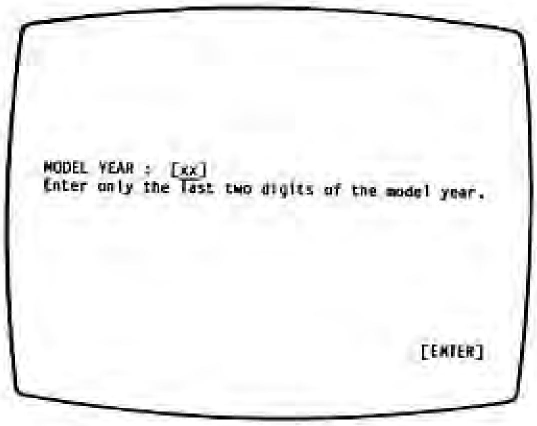
                                          [ENTER]
```

This screen appears if **T** (truck) or **M** (motorhome) was entered for the vehicle type.

- Use the **Cursor** keys to highlight the appropriate vehicle make, then press **ENTER**.

If the vehicle make is not listed, press **CONTINUE** and complete the Unlisted Vehicle screen.

7. MODEL YEAR SCREEN

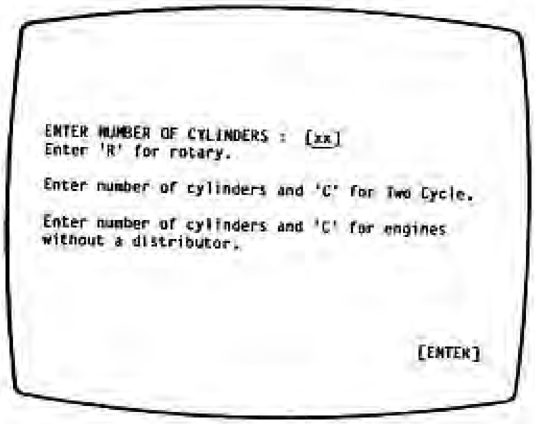


```
MODEL YEAR : [xx]
Enter only the last two digits of the model year.

                                          [ENTER]
```

- Type in the last two digits of the vehicle model year, then press **ENTER**.

8. NUMBER OF CYLINDERS SCREEN



```
ENTER NUMBER OF CYLINDERS : [xx]
Enter 'R' for rotary.

Enter number of cylinders and 'C' for Two Cycle.

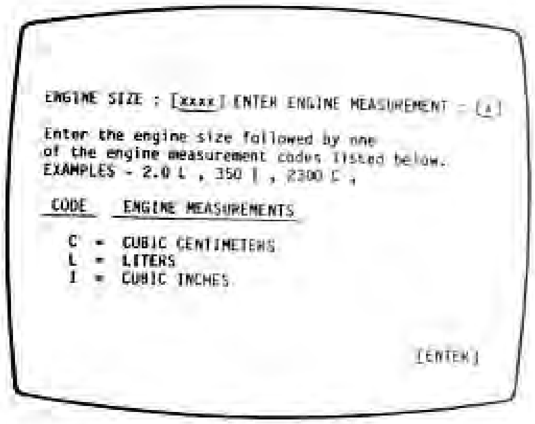
Enter number of cylinders and 'C' for engines
without a distributor.

                                          [ENTER]
```

The Number of Cylinders screen will also tailor the rpm for special engine or ignition classifications.

- Type in the number of engine cylinders or rotors.
- Press **R** for Rotary engine, or **C** for two-cycle and distributorless spark ignition engines, then press **ENTER**.

9. ENGINE SIZE SCREEN



```
ENGINE SIZE : [xxxx] ENTER ENGINE MEASUREMENT - [x]

Enter the engine size followed by one
of the engine measurement codes listed below.
EXAMPLES - 2.0 L , 350 I , 2300 C ,

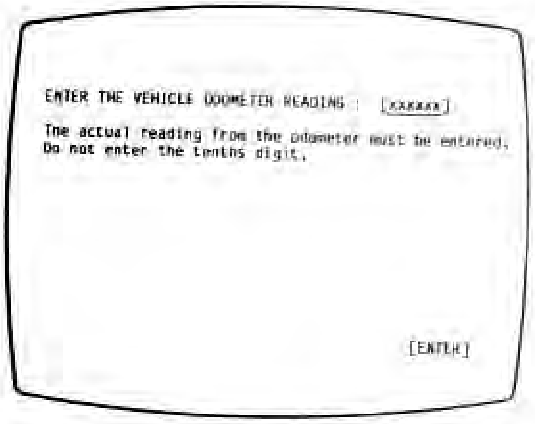
 CODE    ENGINE MEASUREMENTS

   C  =  CUBIC CENTIMETERS
   L  =  LITERS
   I  =  CUBIC INCHES

                                          [ENTER]
```

- Type in the engine size (e.g. 3.8), then press **ENTER**.
- Press **C**, **L**, or **I**, then press **ENTER**; to identify the unit of measure (e.g. cm^3, liters, or in^3).

10. ODOMETER READING SCREEN



```
ENTER THE VEHICLE ODOMETER READING :   [xxxxxx]

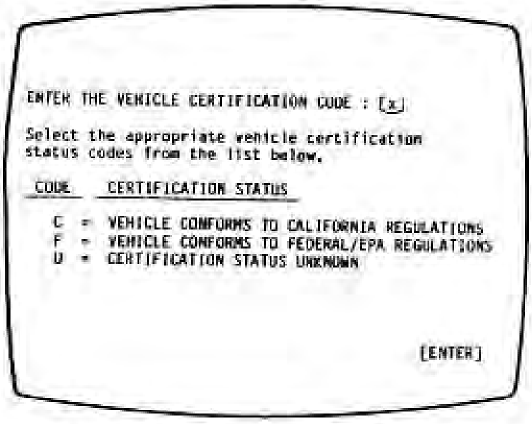
The actual reading from the odometer must be entered.
Do not enter the tenths digit.

                                          [ENTER]
```

- Type in the vehicle's odometer reading (whole miles only), then press **ENTER**.

If the vehicle has less than 7500 miles and is less than 4 years old, go to step 10.1, otherwise, go to step 11.

10.1 EMISSION CLASSIFICATION SCREEN



```
ENTER THE VEHICLE CERTIFICATION CODE : [x]

Select the appropriate vehicle certification
status codes from the list below.

 CODE    CERTIFICATION STATUS

   C  =  VEHICLE CONFORMS TO CALIFORNIA REGULATIONS
   F  =  VEHICLE CONFORMS TO FEDERAL/EPA REGULATIONS
   U  =  CERTIFICATION STATUS UNKNOWN

                                             [ENTER]
```

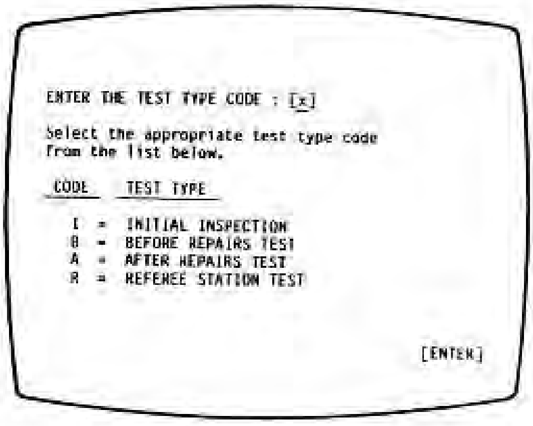
This screen appears for vehicles with less than 7500 miles and less than four years old.

- Press **C**, or **F**, then press **ENTER**; to identify the vehicle's emission classification.

The vehicle's emission classification can be found on the under-hood emissions label. The label will state if the engine is certified for California (C) or Federal (F) use.

- If there is no emission label, press **U** (unknown), then **ENTER**; to display the Escape screen.

11. TEST TYPE SCREEN



```
ENTER THE TEST TYPE CODE : [x]

Select the appropriate test type code
from the list below.

 CODE    TEST TYPE

   I  =  INITIAL INSPECTION
   B  =  BEFORE REPAIRS TEST
   A  =  AFTER REPAIRS TEST
   R  =  REFEREE STATION TEST

                                   [ENTER]
```

- Type in the appropriate **Alpha** code, then press **ENTER**; to identify the test type.

Alpha Codes:

I = Initial inspection or reinspection of failed cars repaired by owner. If all the VIR's from previous tests are lost, the vehicle owner must start again with an "I" Test.

B = Before repair test. This test is used by test/repair facilities to obtain a second opinion prior to repairing the vehicle. The mechanic may opt to substitute "I" test results for the "B" Test. Following repair, an "A" Test is performed.

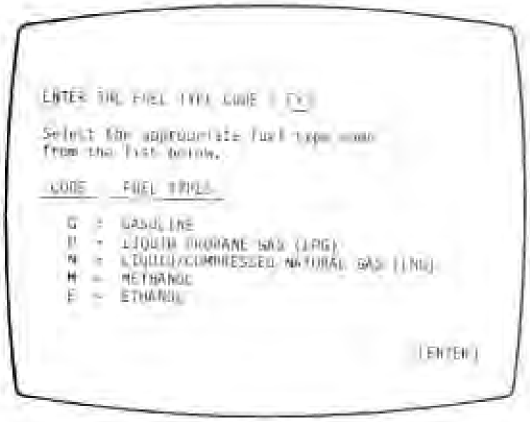
A = After repair emission test. This test is used to check a vehicle after repairs were made to correct a failed "B" or "I" test.

R = Appears for Referee Stations, otherwise its suppressed from appearing. This test is for failed vehicles not covered in "B" and "A".

Previously failed vehicles, after being repaired, resulting in no emission reduction or increased emissions, and which would exceed the cost limits if additional repairs are made, will be referred to a Referee Station for retesting.

In addition, any vehicle brought into a test facility in a condition that would prohibit repair within the established cost limit (as determined by a licensed test inspector prior to testing) shall be referred to a referee station for an "R" test.

12. FUEL TYPE SCREEN



```
ENTER THE FUEL TYPE CODE : [x]

Select the appropriate fuel type code
from the list below.

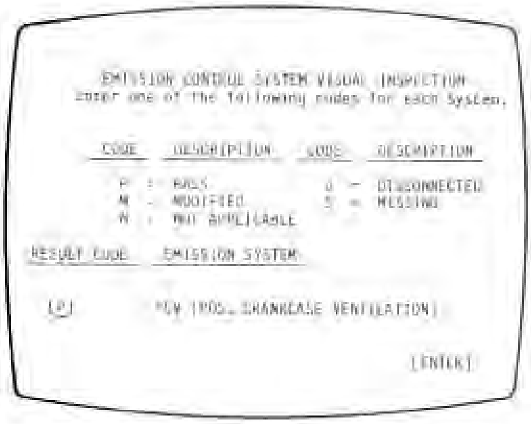
 CODE    FUEL TYPES

   G  =  GASOLINE
   P  =  LIQUID PROPANE GAS (LPG)
   N  =  LIQUID/COMPRESSED NATURAL GAS (LNG)
   M  =  METHANOL
   E  =  ETHANOL

                                   [ENTER]
```

- Type in the appropriate **Alpha** code, then press **ENTER**; to identify the fuel type.

13. VISUAL INSPECTION SCREEN



```
      EMISSION CONTROL SYSTEM VISUAL INSPECTION
    Enter one of the following codes for each System.

      CODE  DESCRIPTION     CODE   DESCRIPTION

        P  =  PASS            D  =  DISCONNECTED
        M  =  MODIFIED        S  =  MISSING
        N  =  NOT APPLICABLE

RESULT CODE   EMISSION SYSTEM

 [P]          PCV (POS. CRANKCASE VENTILATION)

                                        [ENTER]
```

Inspect the vehicle's emission control systems and record your findings on the Visual Inspection screen.

- Press the appropriate **Alpha** code for the emission control system displayed, then press **ENTER**.

Alpha Codes:

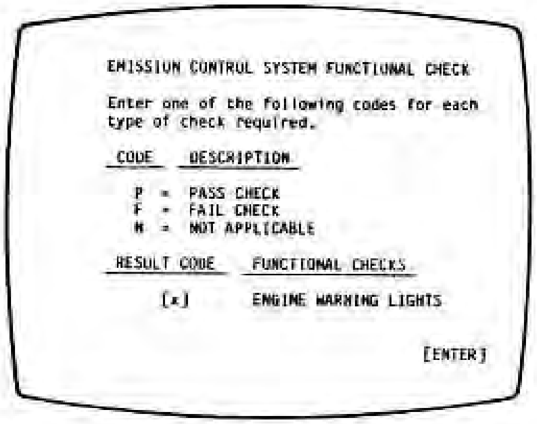
P = Pass
M = Modified
N = Not applicable
D = Disconnected
S = Missing

- Repeat this procedure for each emission control system as it is displayed.

Emission Control Systems:

1. Positive Crankcase Ventilation (PCV).
2. Thermostatic Air Cleaner (TAC).
3. Air Injection / Pulse Air Injection (AI).
4. Fillpipe Restrictor for Fuel Tank (FEC).
5. Oxidizing Catalyst Converter (OX) for two-way oxidation—HC and CO.
6. Three Way Converter (TWC) for oxidation of HC and CO, plus reduction of NOx.
7. Exhaust Gas Recirculation (EGR).
8. Ignition Spark Advance Controls.
9. Closed Loop System (Sensors and Fuel Metering Device).
10. Carburetion or Fuel Injection Controls.
11. Other Emission Related Components (Intake Manifold, Exhaust Headers).
12. Retrofit Systems.

14. FUNCTIONAL INSPECTION SCREEN



```
EMISSION CONTROL SYSTEM FUNCTIONAL CHECK

Enter one of the following codes for each
type of check required.

 CODE    DESCRIPTION

   P  =  PASS CHECK
   F  =  FAIL CHECK
   N  =  NOT APPLICABLE

 RESULT CODE    FUNCTIONAL CHECKS

     [x]        ENGINE WARNING LIGHTS

                                  [ENTER]
```

- Report the condition of each functional check item.
- Type in **P** (pass), **F** (fail), or **N** (not applicable) for the first item displayed, then press **ENTER**.

Any **F** (fail) entry will cause a failed certification test.

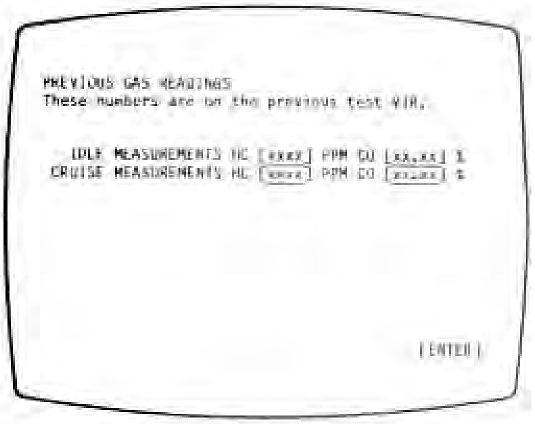
- Repeat this procedure for each item as it is displayed.

The number of items displayed depends on geographic location of the testing facility.

Functional Check Items:

1. Engine Warning Lights.
2. Ignition Spark Timing.
3. EGR Operation.

14.1 PREVIOUS GAS READINGS



```
PREVIOUS GAS READINGS
These numbers are on the previous test VIR.

  IDLE MEASUREMENTS HC [xxxx] PPM CO [xx.xx] %
CRUISE MEASUREMENTS HC [xxxx] PPM CO [xx.xx] %

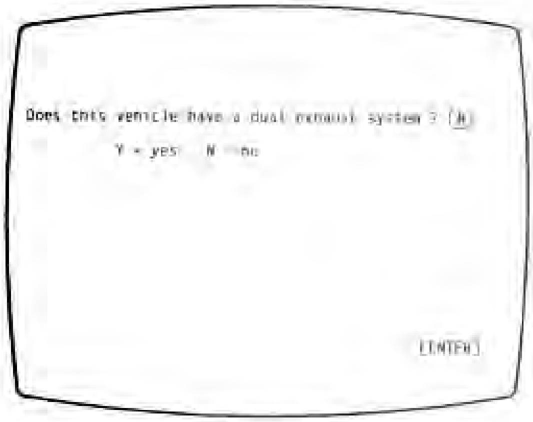
                                      [ENTER]
```

This screen appears if **A** (after repair) or **R** (referee station) was entered for the test type.

Enter the gas readings from the previous Vehicle Inspection Report (VIR).

- Type in the idle HC value, then press **ENTER**.
- Type in the idle CO value with decimal, then press **ENTER**.
- Repeat this procedure for the cruise values.

15. DUAL EXHAUST QUERY SCREEN



```
Does this vehicle have a dual exhaust system ? [N]

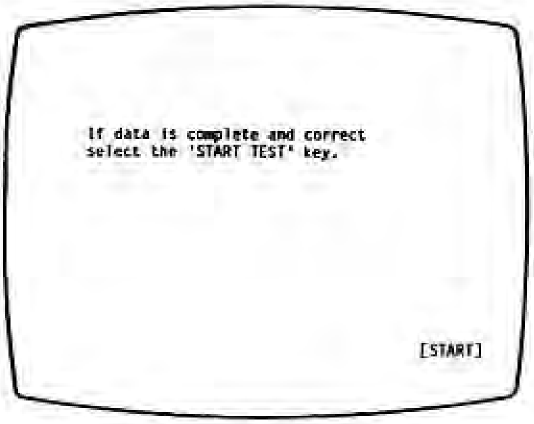
        Y = yes   N = no

                                      [ENTER]
```

Dual exhaust systems have separate pipes from the exhaust manifold back. The presence of dual tailpipes does not always mean the vehicle has dual exhaust.

- Press **Y** (yes) or **N** (no), then press **ENTER**, to answer the Dual Exhaust query.

16. START TEST SCREEN



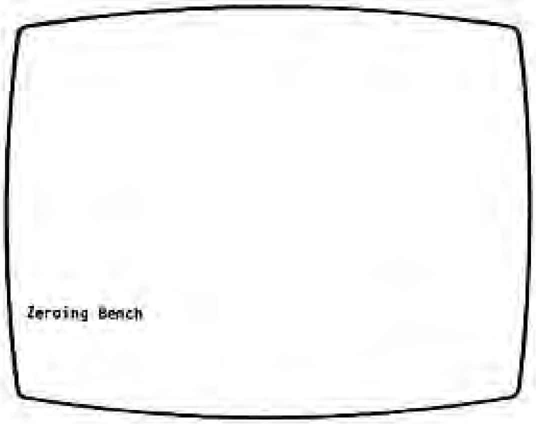
If data is complete and correct
select the 'START TEST' key.

[START]

Pressing the **Start Test** key deactivates the review and erase function keys until after the exhaust gas analysis.

- If the previously entered data is complete and correct, press **START TEST**.

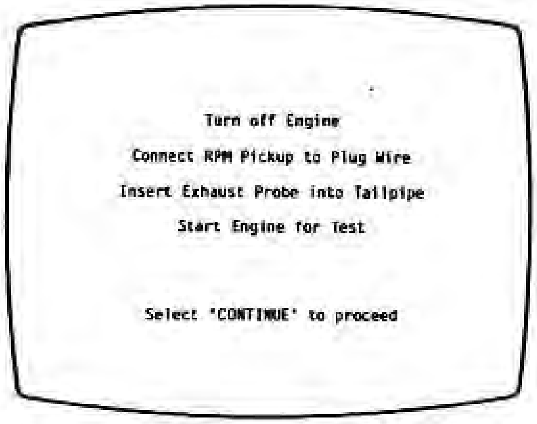
17. ZEROING BENCH SCREEN



Zeroing Bench

This screen is displayed for a minute while the bench is zeroed to room air. The test routine automatically proceeds when the bench is zeroed.

18. PREPARE FOR TEST SCREEN



Turn off Engine

Connect RPM Pickup to Plug Wire

Insert Exhaust Probe into Tailpipe

Start Engine for Test

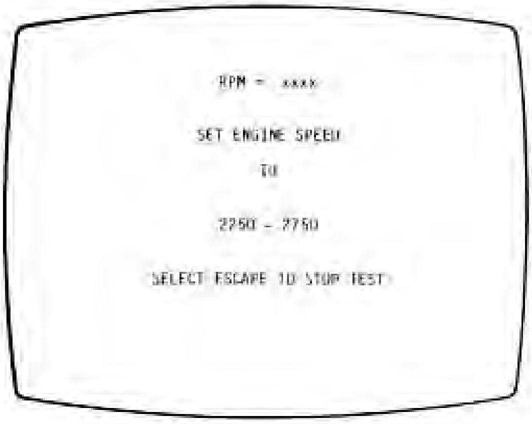
Select 'CONTINUE' to proceed

- Prepare the vehicle for the Certification test, then press **CONTINUE**.

1. Turn off the engine.
2. Connect the rpm pickup to any plug wire with the arrow pointing towards the spark plug.
3. Start the engine to warm and stabilize the engine temperature.
4. Insert the exhaust probe at least 12 inches into the tailpipe.

The messages, Turn off Engine and Start Engine and Idle, appears for 1981 and newer Ford Motor Co. vehicles to stabilize their gas readings. Follow the prompts and the test automatically proceeds.

19. SET ENGINE CRUISE SPEED SCREEN



RPM = xxxx

SET ENGINE SPEED

TO

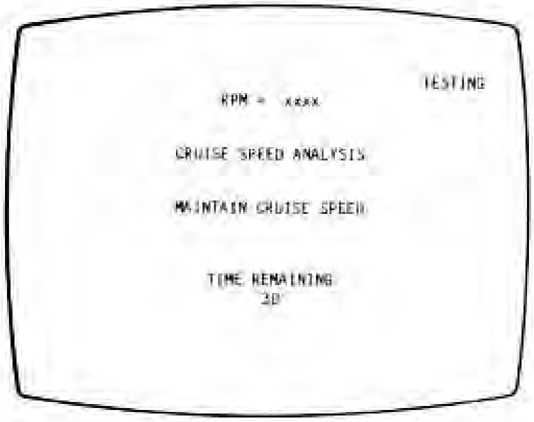
2250 - 2750

SELECT ESCAPE TO STOP TEST

This screen appears when the rpm is out of the specified speed range.

- Set the throttle at a fixed position to maintain a steady rpm within in the range indicated on the screen (2250-2750). The test automatically proceeds.

20. CRUISE ANALYSIS SCREEN



TESTING

RPM = xxxx

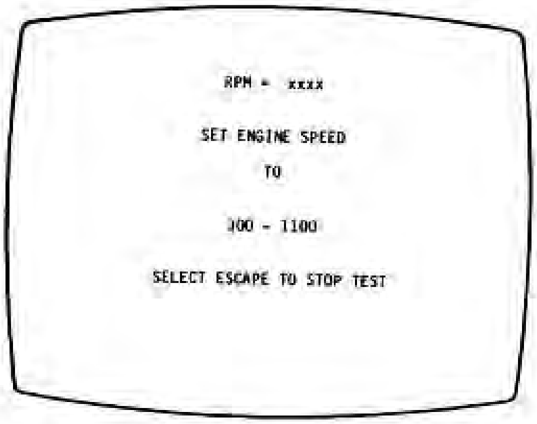
CRUISE SPEED ANALYSIS

MAINTAIN CRUISE SPEED

TIME REMAINING
30

This screen is displayed during the exhaust sampling cycle. If rpm or dilution violate the testing standard, the test and countdown clock will automatically restart.

21. SET ENGINE IDLE SPEED SCREEN



```
RPM = xxxx

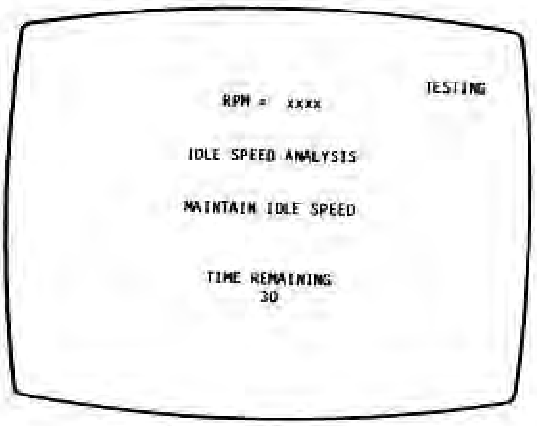
SET ENGINE SPEED
TO

300 - 1100

SELECT ESCAPE TO STOP TEST
```

- Release the throttle to allow the engine to idle.
- Set the throttle at a fixed position to maintain a steady rpm within the range indicated on the screen (e.g. 300-1100). The test automatically proceeds.

22. IDLE ANALYSIS SCREEN



```
                              TESTING
        RPM =  xxxx

IDLE SPEED ANALYSIS

MAINTAIN IDLE SPEED

TIME REMAINING
      30
```

This screen is displayed during the exhaust sampling cycle. If rpm or dilution violate the testing standards, the test and countdown clock will automatically restart.

TEST COMPLETION OPTIONS

1. For an "I" or "B" test, go to Completing an "I" or "B" test.
2. For an "A" or "R" test, go to Completing an "A" or "R" test.

- Follow the option that corresponds to your test

The **Last Entry, Next Entry, Clear** and **Delete** keys are active to review and correct data entry mistakes on the remaining screens.

Option 1, Completing an "I" or "B" Test.

Now TAS evaluates the current test data for state compliance and selects one of the following program paths.

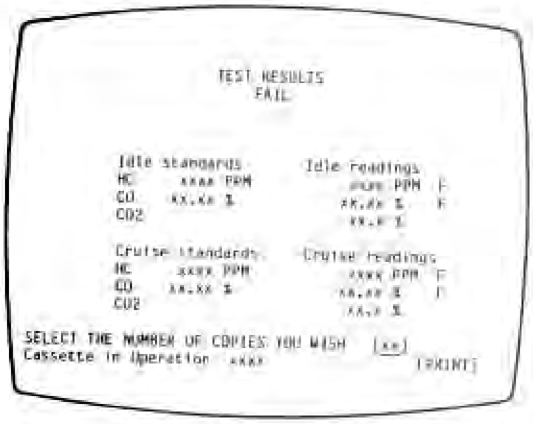
1. A certificate rejection path displays a final Failed Result screen next.
2. A certificate approval path displays a Certificate Number screen next.

- Follow the path that corresponds to your test.

Certificate rejection path

The test vehicle does not qualify for a certificate because it fails to comply to the state I&M Program. The test result is based on the visual and functional inspections,and the exhaust emission analysis.

TEST RESULTS—FAIL



```
                 TEST RESULTS
                     FAIL

Idle standards          Idle readings
HC      xxxx PPM             xxxx PPM  F
CO     xx.xx %              xx.xx %    F
CO2                          xx.x %

Cruise standards        Cruise readings
HC      xxxx PPM             xxxx PPM  F
CO     xx.xx %              xx.xx %    F
CO2                          xx.x %
SELECT THE NUMBER OF COPIES YOU WISH  [xx]
Cassette in Operation  xxxx                [PRINT]
```

This is the final screen for a failed "I" or "B" test. Tests that fail because emission standards are exceeded have the letter "F" next to each failed gas reading.

- Select any number of copies you wish, then press **PRINT**.

The number "2" is preselected (one printout for the customer and one for the shop files).

Use Smart or Network Diagnostic Mode (PTC section 3) to identify needed repairs/adjustments.

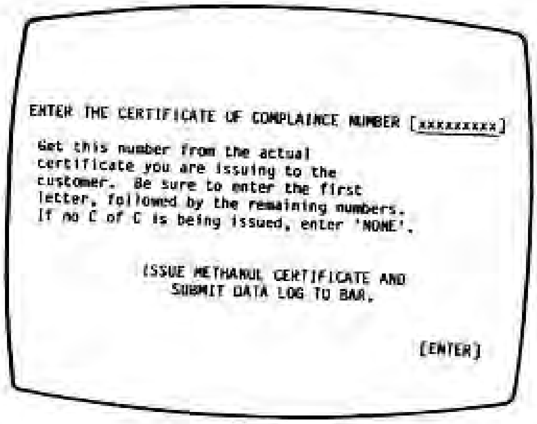
- Repair and retest using the "A" test.

Certificate approval path

The vehicle qualifies for a certificate because it complies with the state I & M Program.

TAS selects a Compliance or Non-Compliance certificate screen based on the vehicle's age, mileage, and emission classification found on the underhood sticker (California or Federal).

COMPLIANCE NUMBER SCREEN



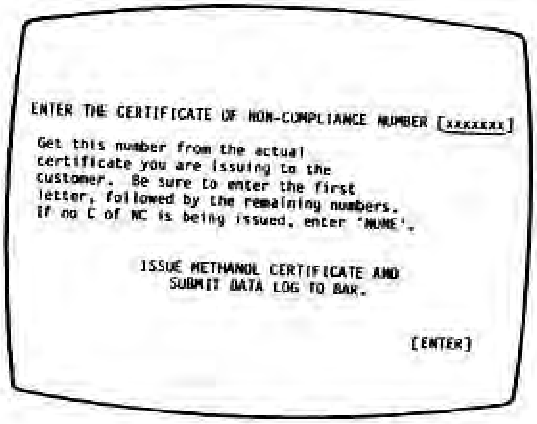
```
ENTER THE CERTIFICATE OF COMPLAINCE NUMBER [xxxxxxxxx]
 Get this number from the actual
 certificate you are issuing to the
 customer.  Be sure to enter the first
 letter, followed by the remaining numbers.
 If no C of C is being issued, enter 'NONE'.

            ISSUE METHANOL CERTIFICATE AND
               SUBMIT DATA LOG TO BAR.

                                          [ENTER]
```

- Type in the certificate letter followed by the number you will issue the customer, then press **ENTER**.
- If no certificate will be issued, type in **NONE**, then press **ENTER**.
- If the vehicle uses methanol fuel, issue a Methanol sticker in addition to any other certificates.

NON-COMPLIANCE NUMBER SCREEN



```
ENTER THE CERTIFICATE OF NON-COMPLIANCE NUMBER [xxxxxxx]
 Get this number from the actual
 certificate you are issuing to the
 customer.  Be sure to enter the first
 letter, followed by the remaining numbers.
 If no C of NC is being issued, enter 'NONE'.

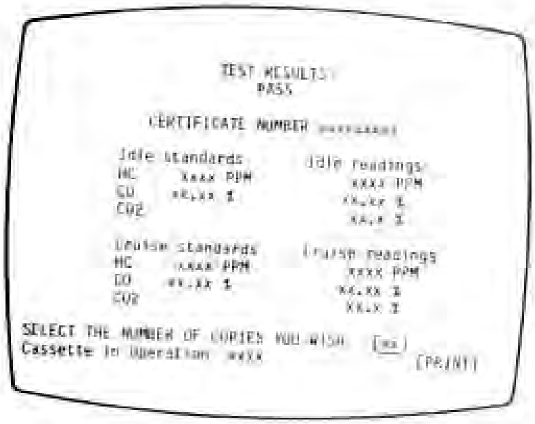
            ISSUE METHANOL CERTIFICATE AND
               SUBMIT DATA LOG TO BAR.

                                          [ENTER]
```

The C of N/C is for Federal cars with less than 7500 miles and less and 4 years old.

- Type in the certificate letter followed by the number you will issue the customer, then press **ENTER**.
- If no certificate will be issued, type in **NONE** then press **ENTER**.
- If the vehicle uses methanol fuel, issue a Methanol sticker in addition to any other certificates.

TEST RESULTS—PASS



```
                    TEST RESULTS
                        PASS

            CERTIFICATE NUMBER xxxxxxxxx

        Idle standards          Idle readings
        HC      xxxx PPM             xxxx PPM
        CO     xx.xx %              xx.xx %
        CO2                          xx.x %

        Cruise standards        Cruise readings
        HC      xxxx PPM             xxxx PPM
        CO     xx.xx %              xx.xx %
        CO2                          xx.x %

SELECT THE NUMBER OF COPIES YOU WISH  [xx]
Cassette In Operation  xxxx
                                            [PRINT]
```

This is the final screen in a Passing "I" or "B" test and indicates the certificate number just entered.

- Select any number of copies you wish, press **PRINT**.

The number 2 is preselected (one printout for the customer and one for the shop files).

The Set-up screen is displayed when printing is finished.

Option 2, Completing an "A" or "R" Test

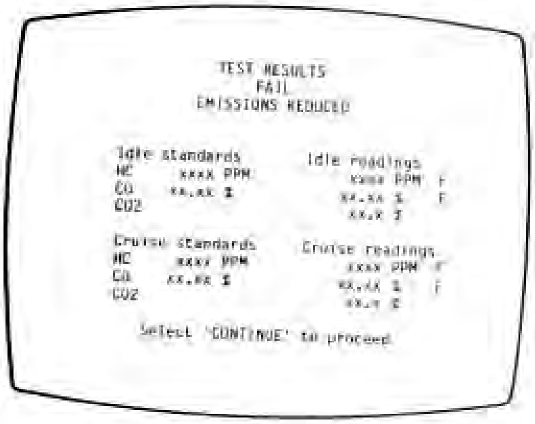
- Complete the Test Result, Parts Cost, Labor Cost, Repair Action, Estimated Repair Cost, and State Approval screens.

When finished, the TAS evaluates the current data for state compliance and selects one of the following program paths.

1. Certificate rejection path displays a final Failed Result screen.
2. Certificate approval path displays a Certificate Number screen.

- Complete the following data entry screens, then follow the program path (rejection/approval) that corresponds to your test.

INITIAL TEST RESULTS—PASS/FAIL



```
                    TEST RESULTS
                        FAIL
                 EMISSIONS REDUCED

        Idle standards          Idle readings
        HC      xxxx PPM             xxxx PPM   F
        CO     xx.xx %              xx.xx %     F
        CO2                          xx.x %

        Cruise standards        Cruise readings
        HC      xxxx PPM             xxxx PPM   F
        CO     xx.xx %              xx.xx %     F
        CO2                          xx.x %

            Select 'CONTINUE' to proceed.
```

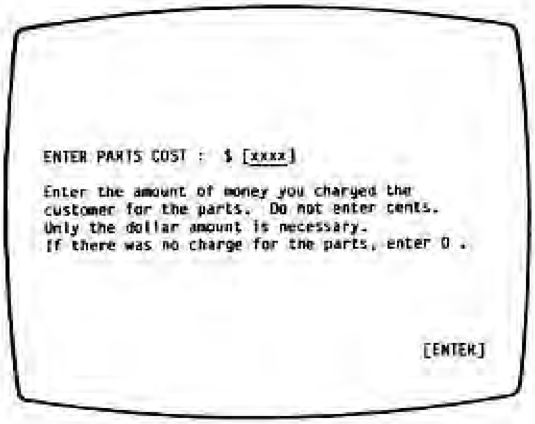
This screen appears with Pass or Fail based on the result of the visual and functional inspections and the exhaust emission check.

When a vehicle fails because the emission standards are exceeded, the screen has Fail with Emissions Reduced or Emissions Not Reduced. The failed gas reading are indicated with the letter "F" next to them. This vehicle may still qualify for a certificate if both of the following are met.

1. The emissions are reduced at least 10% from the levels in the "I" or "B" test.
2. The cost of repairing the vehicle to meet the emission standards will or have exceeded the repair cost limit set by the state.

- Press **CONTINUE** to proceed.

PARTS COST SCREEN



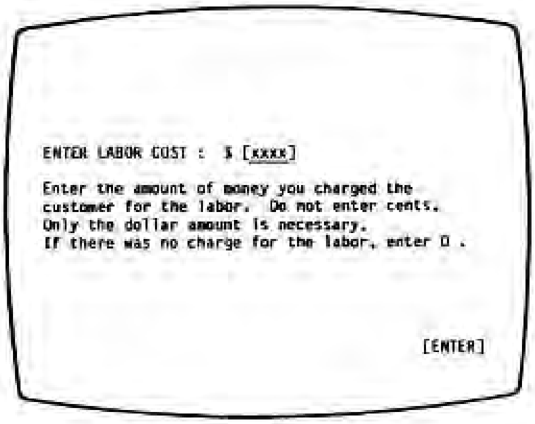
```
ENTER PARTS COST :  $ [xxxx]

Enter the amount of money you charged the
customer for the parts.  Do not enter cents.
Only the dollar amount is necessary.
If there was no charge for the parts, enter 0 .

                                        [ENTER]
```

- Type in the whole dollar amount for the cost of repair parts or **0** (zero) for no charge, then press **ENTER**.

LABOR COST SCREEN



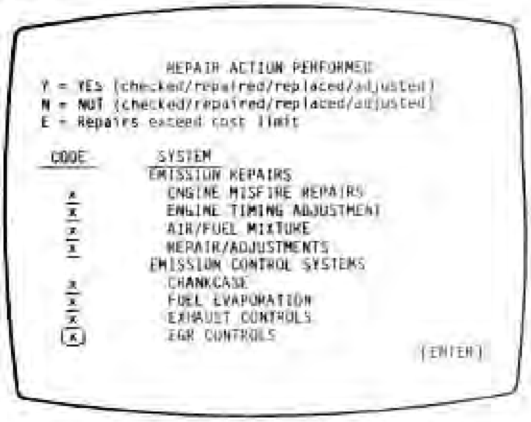
```
ENTER LABOR COST :  $ [xxxx]

Enter the amount of money you charged the
customer for the labor.  Do not enter cents.
Only the dollar amount is necessary.
If there was no charge for the labor, enter 0 .

                                        [ENTER]
```

- Type in the whole dollar amount for the cost of labor or 0 (zero) for no charge, then press **ENTER**.

REPAIR ACTION SCREEN



```
              REPAIR ACTION PERFORMED
Y = YES (checked/repaired/replaced/adjusted)
N = NOT (checked/repaired/replaced/adjusted)
E = Repairs exceed cost limit

 CODE         SYSTEM
            EMISSION REPAIRS
   x          ENGINE MISFIRE REPAIRS
   x          ENGINE TIMING ADJUSTMENT
   x          AIR/FUEL MIXTURE
   x          REPAIR/ADJUSTMENTS
            EMISSION CONTROL SYSTEMS
   x          CRANKCASE
   x          FUEL EVAPORATION
   x          EXHAUST CONTROLS
  (x)         EGR CONTROLS
                                     [ENTER]
```

- Type in the appropriate **Alpha** code for first system, then press **ENTER**.
- Repeat this procedure for all remaining systems.

Repair Action Code:

Y = Yes; was checked, repaired, replaced, or adjusted.

N = Not; checked, repaired, replaced, or adjusted.

E = Repairs have or would exceed the cost limit.

Have Exceeded:

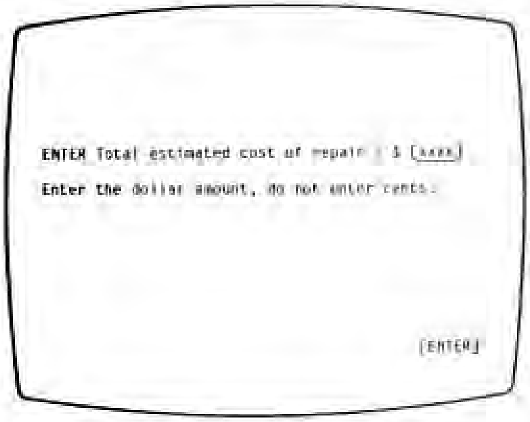
If the parts plus labor cost now exceed the cost limit press **E** for exceeds.

Would Exceed:

If the parts plus labor cost do not exceed the cost limit now, estimate the additional repair cost needed to get the vehicle to meet the emission standards. Add this additional amount to the previous parts and labor cost to see if the cost limit would be exceeded. If this amount exceeds the cost of repair limit, press **E** for exceeds.

The Total Estimated Cost Of Repair screen will appear only if an "E" is selected.

ESTIMATED REPAIR COST SCREEN



```
ENTER Total estimated cost of repair : $ [xxxx]

Enter the dollar amount, do not enter cents.

                                          [ENTER]
```

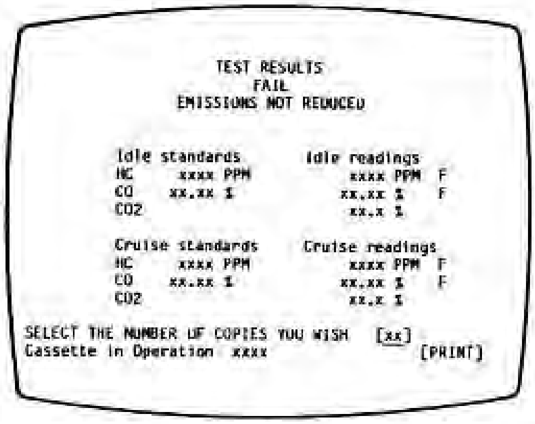
Estimate the additional repair cost needed to get the vehicle to pass emission standards. This additional amount does not include the previously entered parts cost or labor cost.

- Type in the estimated additional repair cost (whole dollars), then press **ENTER**.

Certificate rejection path

The test vehicle does not qualify for a certificate because it fails to comply with the state I&M Program. The test result is based on the visual and functional inspection, exhaust emission analysis, and repair cost.

FINAL TEST RESULT—FAIL



```
                    TEST RESULTS
                        FAIL
               EMISSIONS NOT REDUCED

        Idle standards        Idle readings
        HC      xxxx PPM            xxxx PPM  F
        CO     xx.xx %             xx.xx %    F
        CO2                         xx.x %

        Cruise standards      Cruise readings
        HC      xxxx PPM            xxxx PPM  F
        CO     xx.xx %             xx.xx %    F
        CO2                         xx.x %

SELECT THE NUMBER OF COPIES YOU WISH   [xx]
Cassette in Operation  xxxx                 [PRINT]
```

This is the last "A" or "R" test screen for vehicles that exceed emission standards. However, the reason the vehicle did not qualify for a certificate is, the emissions were not reduced at least 10%, and/or the repair cost limit was not exceeded.

- Select any number of copies you wish, then press **PRINT**.

The number "2" is preselected (one printout for the customer and one for the shop files).

The Set-up screen is displayed when printing if finished.

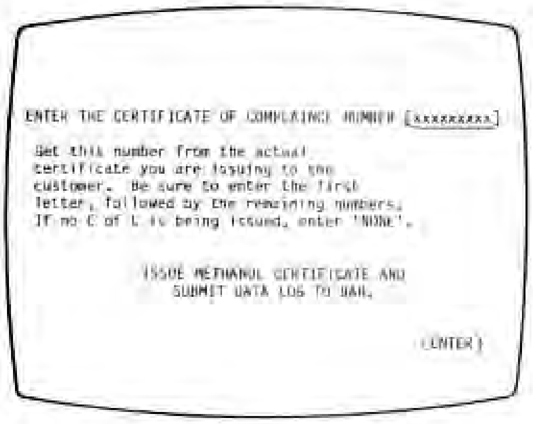
Use Smart or Network Diagnostic Mode (PTC section 3) to identify needed repairs, adjustments.

Certificate approval path

The vehicle qualifies for a certificate because it complies with the state I&M Program.

TAS selects a Compliance or Non-Compliance certificate screen based on the vehicle's age, mileage, and emission classification found on the underhood sticker (California or Federal).

COMPLIANCE NUMBER SCREEN



```
ENTER THE CERTIFICATE OF COMPLIANCE NUMBER [xxxxxxxxx]

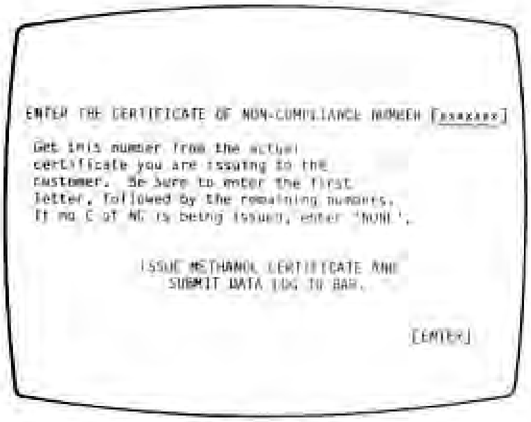
 Get this number from the actual
 certificate you are issuing to the
 customer.  Be sure to enter the first
 letter, followed by the remaining numbers.
 If no C of C is being issued, enter 'NONE'.

              ISSUE METHANOL CERTIFICATE AND
                 SUBMIT DATA LOG TO BAR.

                                        [ENTER]
```

- Type in the certificate letter followed by the number y will issue the customer, then press **ENTER**.
- If no certificate will be issued, type in **NONE**, then pre **ENTER**.
- If the vehicle uses methanol fuel, issue a Methan sticker in addition to any other certificates.

NON-COMPLIANCE NUMBER SCREEN



```
ENTER THE CERTIFICATE OF NON-COMPLIANCE NUMBER [xxxxxxx]

 Get this number from the actual
 certificate you are issuing to the
 customer.  Be sure to enter the first
 letter, followed by the remaining numbers.
 If no C of NC is being issued, enter 'NONE'.

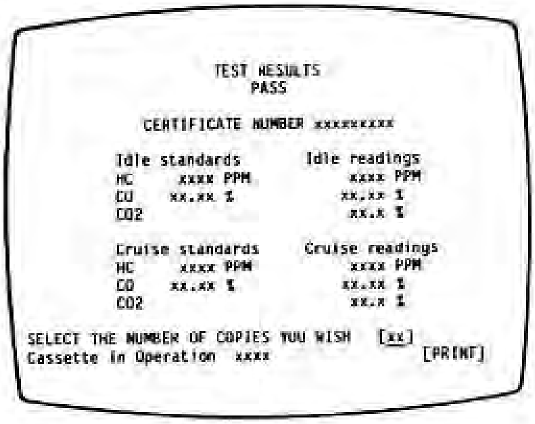
              ISSUE METHANOL CERTIFICATE AND
                 SUBMIT DATA LOG TO BAR.

                                        [ENTER]
```

The C of N/C is for federal cars with less than 7500 miles a less than 4 years old.

- Type in the first letter followed by the number you w issue the customer, then press **ENTER**.
- If no certificate will be issued, enter "None" on th keyboard; press **ENTER**.
- If the vehicle uses methanol fuel, issue a Methan sticker in addition to any other certificates.

FINAL TEST RESULTS—PASS



```
                    TEST RESULTS
                        PASS

           CERTIFICATE NUMBER xxxxxxxxx

        Idle standards          Idle readings
        HC      xxxx PPM             xxxx PPM
        CO    xx.xx %               xx.xx %
        CO2                          xx.x %

        Cruise standards        Cruise readings
        HC      xxxx PPM             xxxx PPM
        CO    xx.xx %               xx.xx %
        CO2                          xx.x %

SELECT THE NUMBER OF COPIES YOU WISH   [xx]
Cassette in Operation  xxxx                  [PRINT]
```

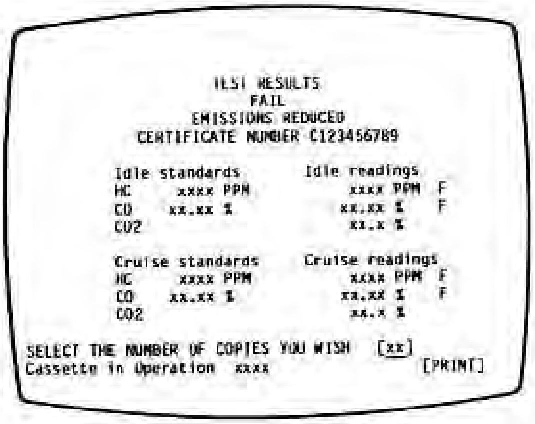
This is the last "A" or "R" test screen for vehicles that pass the emission standards. The certificate number is indicated on the screen.

- Select any number of copies you wish, then press **PRINT**.

The number 2 is preselected (one printout for the customer and one for the shop files).

The Set-up screen is displayed when printing is finished.

FINAL TEST RESULTS—FAIL



```
                    TEST RESULTS
                        FAIL
                  EMISSIONS REDUCED
           CERTIFICATE NUMBER C123456789

        Idle standards          Idle readings
        HC      xxxx PPM             xxxx PPM  F
        CO    xx.xx %               xx.xx %    F
        CO2                          xx.x %

        Cruise standards        Cruise readings
        HC      xxxx PPM             xxxx PPM  F
        CO    xx.xx %               xx.xx %    F
        CO2                          xx.x %

SELECT THE NUMBER OF COPIES YOU WISH   [xx]
Cassette in Operation  xxxx                  [PRINT]
```

This is the last "A" or "R" test screen for vehicles that fail the emission standards but qualify for a certificate anyway. This is because their emissions were reduced at least 10% and the cost of repair exceeded the legal cost limit.

- Select any number of copies you wish, then press **PRINT**.

The number 2 is preselected (one printout for the customer and one for the shop files).

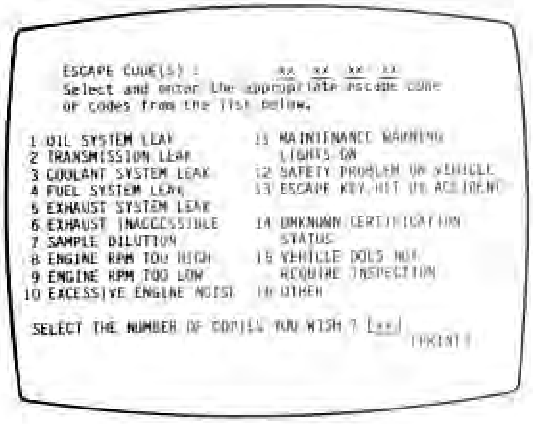
The Set-up screen is displayed when printing is finished.

OTHER CERTIFICATION TEST SCREENS

The following screens can appear depending on the selections made on the Data Entry screens (vehicle features, type of test, etc.).

- Complete the appropriate screens.

ESCAPE SCREEN



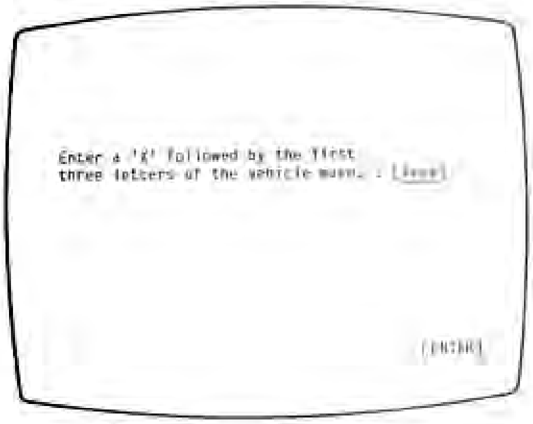
```
   ESCAPE CODE(S) :          xx  xx  xx  xx
   Select and enter the appropriate escape code
   or codes from the list below.

 1 OIL SYSTEM LEAK          11 MAINTENANCE WARNING
 2 TRANSMISSION LEAK           LIGHTS ON
 3 COOLANT SYSTEM LEAK      12 SAFETY PROBLEM ON VEHICLE
 4 FUEL SYSTEM LEAK         13 ESCAPE KEY HIT BY ACCIDENT
 5 EXHAUST SYSTEM LEAK
 6 EXHAUST INACCESSIBLE     14 UNKNOWN CERTIFICATION
 7 SAMPLE DILUTION             STATUS
 8 ENGINE RPM TOO HIGH      15 VEHICLE DOES NOT
 9 ENGINE RPM TOO LOW          REQUIRE INSPECTION
10 EXCESSIVE ENGINE NOISE   16 OTHER

 SELECT THE NUMBER OF COPIES YOU WISH ? [xx]
                                          [PRINT]
```

- Type in a code that corresponds to the reason for exiting the test, then press **ENTER**.
- Select up to four codes.
- Type in the number of copies desired, then press **PRINT**. Give one copy to the customer and place the other in the shop file.

UNLISTED VEHICLE SCREEN



```
   Enter a 'X' followed by the first
   three letters of the vehicle make. : [xxxx]

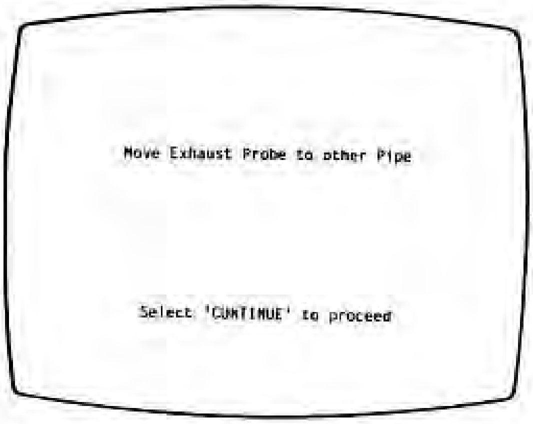



                                              [ENTER]
```

This screen is used if the vehicle make is not listed on the Vehicle Make screen.

- Type in **X** and the first three letters of the vehicle make, then press **ENTER**.

MOVE EXHAUST PROBE SCREEN



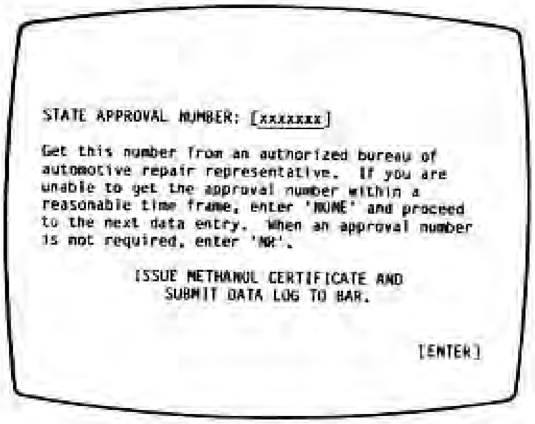
```
Move Exhaust Probe to other Pipe

Select 'CONTINUE' to proceed
```

This screen appears for vehicles identified as dual exhaust equipped.

- Move the exhaust probe to the other pipe, then press **CONTINUE**; to repeat the idle and cruise analysis.

STATE APPROVAL NUMBER SCREEN



```
STATE APPROVAL NUMBER: [xxxxxxx]

Get this number from an authorized bureau of
automotive repair representative.  If you are
unable to get the approval number within a
reasonable time frame, enter 'NONE' and proceed
to the next data entry.  When an approval number
is not required, enter 'NR'.

            ISSUE METHANOL CERTIFICATE AND
               SUBMIT DATA LOG TO BAR.

                                          [ENTER]
```

When activated from suppression, this screen appears before the Certificate Number screen for "A" and "R" tests only.

- Type in the State Approval number, then press **ENTER**.

This certificate number must be obtained from an authorized B.A.R. representative.

- If a number is unavailable, enter **NONE**. When an approval number is not required, press **NR**, then press **ENTER**.

FAULT/HELP PROMPTS

The following Fault prompts can be displayed depending on the gas and rpm values sensed during the Certification test and responses to the Data Entry screens.

PLACE EXHAUST PROBE ON HOOK : Appears, prior to completing the Data Entry screens, when the analyzer senses excessive residual HC in the sample system. While the operator completes the Data Entry screens, the analyzer will draw room air through the exhaust probe to purge residual HC from the sample system. To ensure efficient purging, verify that the probe is out of the tailpipe and four feet above the shop floor—the floor area may contain heavy vapors.

- Place the exhaust probe on the probe hook, then pr **CONTINUE**.

INVALID ACCESS CODE: Appears when entering the wr access code. The routine aborts to the Set-up screen. Fur progress is rejected until the operator enters an access co that the analyzer recognizes.

VEHICLES OVER 8500 lbs. GVWR DO NOT NEED TO TESTED....: The analyzer will not test vehicles over 8500 Reenter the proper vehicle weight, or exit the test.

VEHICLES OLDER THAN 1955 SHOULD NOT BE RUN ON TH ANALYZER....: The analyzer will not test vehicles older th 1955. Enter the proper year, or exit the test.

NUMBER OF ENGINE CYLINDERS NOT VALID, TRY AGAI Appears if over 16 cylinders are entered. Enter the pro number of cylinders, or exit the test.

ENTER ONE TYPE OF CATALYST: Appears if the vehicl entered as having both types of converters. Enter a **N** (applicable) for one type.

POSSIBLE DIRTY FILTERS OR SAMPLE LINE PURGI SYSTEM....: Appears after pressing **Start Test** and indica the analyzer senses excessive HC in the sample system, ev after purging during the Data Entry screens. This HC hang can be caused by excessive residual HC in the sample circ and/or the infrared bench zero calibration has drifted caus the analyzer to see more than 20 ppm in the sample syste Also, the operator may have neglected to hang the exha probe on the probe hook.

During data entry by the operator, the sample system purged through the exhaust probe. To ensure effici purging, the probe must be in a suitable fresh environment:

1. Out of the tailpipe
2. Three or four feet above the shop floor
3. Clean room air

Further progress is rejected until the hang-up problem fixed. After ten minutes of purging, the message HC Ha Up Problem In Sample Line briefly appears before the E cape screen is displayed.

A residual HC problem is generally cleared by:

1. Extended purging
2. Changing the sample filters
3. Cleaning the sample circuit

A zero drift problem is indicated when the HC reading is hi and steady, even after extended purging.

- Press **ZERO BENCH** to adjust the digital readouts zero.
- Refer to PTC section 4— TAS Service mode, Man Operation—item 6, HC Hang-up diagnosis; and H Hang-up Test—item 4.

Three ways to access the Manual Operation Mode:

1. Enter **2** from the Set-up screen.
2. Enter **6** from the Service Mode menu screen.
3. Enter **17** from the Service Mode menu screen.

HC HANGUP IN SAMPLE LINE: Appears briefly before Escape screen is displayed and indicates that extend purging failed to fix the HC hang-up. Accurate emissi testing is not possible until the hang-up is fixed. Refer to PT section 4—TAS Service mode, Manual Operation— item 6, HC Hang-up Diagnosis.

LOW FLOW: This fault prompt is triggered during a zero bench routine when poor flow through the exhaust sample circuit is detected. Correct the fault and the test automatically proceeds. If not, further progress is rejected and a unit malfunction is set.

Repair the fault and perform a zero bench routine to clear the malfunction. To immediately exit the test for repairs; press **ESCAPE**. After 10 minutes of low flow, the test automatically aborts to the Set-up screen.

- Check for any restrictions in the sample line, filters, and drain hose.
- To perform a zero bench routine; press **ZERO BENCH**.

See PTC section 4—TAS Service mode, Unit Malfunction—item 2; to clear the malfunction.

See PTC section 5—TAS Maintenance, Filter Change Procedure.

NO RPM SIGNAL : Indicates no tach signal is sensed. Correct the fault and the test automatically proceeds. If not, further progress is rejected.

1. Verify that the engine is running.
2. Try connecting to another plug wire.
3. Check the rpm pickup for proper connection to the TAS unit and engine.

- If repair is necessary, press **ESCAPE** to exit the test.

ERRATIC RPM SIGNAL : Indicates the engine rpm is rough or the pickup is receiving electrical noise.

- Repair the fault and press **CONTINUE**.

1. Check for faulty ignition parts.
2. Try moving the pickup to another plug.

- If necessary, press **ESCAPE** to exit the test.

CO_2 DILUTION ERROR : Indicates a low CO_2 value is sensed during exhaust analysis. Exhaust sample dilution is indicated. Accurate testing is not possible with a diluted sample. Correct the fault and the test automatically proceeds. If not—further progress is rejected. See PTC section 4—TAS Service mode, Manual Operation—item 6, Operator's Leak Test, to check for air leaks.

1. Check exhaust probe insertion depth.
2. Check for air leaks into the vehicle exhaust system, TAS probe, hose, or filter system.

- If necessary, press **ESCAPE** to stop the test.

SECTION 2
MANUAL OPERATION MODE

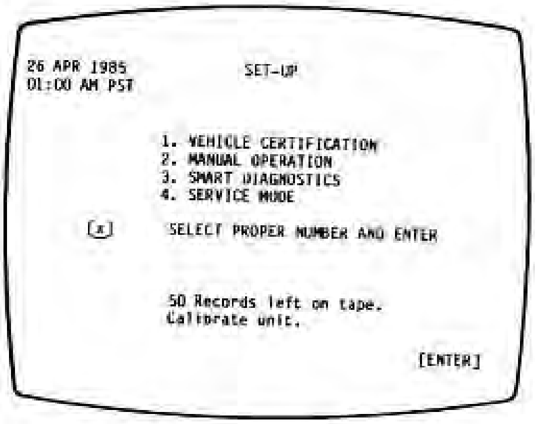
The Manual Operating Mode enables the EPA emission Analyzer to be used as a conventional exhaust analyzer and tachometer. This flexibility allows the operator to direct and expand testing as needed.

The infrared bench analyzes the exhaust sample for carbon monoxide (CO), hydrocarbons (HC), and carbon dioxide (CO_2). If an oxygen (O_2) option is installed and enabled, the sample is then analyzed by the O_2 sensor.

The monitor shows the exhaust gas and rpm values in a live, easy to read, digital display. The printer captures this live data on paper for later evaluation or documentation.

USING THE MANUAL OPERATING MODE

- Complete the daily Warm-up procedure to display the Set-up screen for operating mode selection.



```
26 APR 1985              SET-UP
01:00 AM PST


                 1. VEHICLE CERTIFICATION
                 2. MANUAL OPERATION
                 3. SMART DIAGNOSTICS
                 4. SERVICE MODE

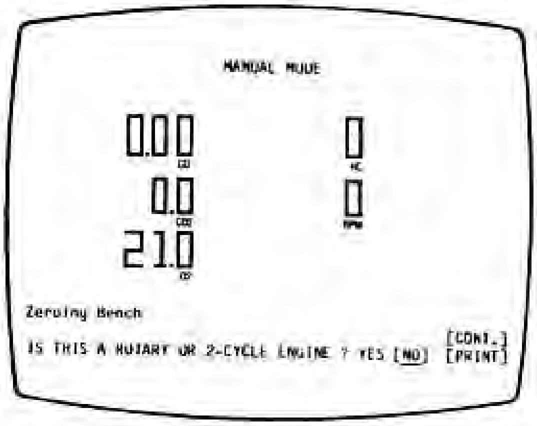
       [x]        SELECT PROPER NUMBER AND ENTER



                  50 Records left on tape.
                  Calibrate unit.

                                          [ENTER]
```

- Press **2**, then **ENTER**; to select Manual Operation mode from the Set-up screen.
- All functions of Manual Operation are now activated.
- To purge the sample system, hang the exhaust probe on the TAS probe hook.



```
                     MANUAL MODE

          0.00               0
            CO                HC
           0.0               0
            CO2               RPM
          21.0
            O2

Zeroing Bench

                                              [CONT.]
IS THIS A ROTARY OR 2-CYCLE ENGINE ? YES [NO] [PRINT]
```

- Use the horizontal **Cursor** keys to indicate the engine cycle.
- Check the gas values. If the probe is out of the exhaust pipe the CO, HC and CO_2 values should be very near zero. O_2 will read 21.0%
- Press the **Zero Bench** key if the gas values are steady but still slightly different than fresh air values.
- Check for an HC hang-up if the HC is high and extended fresh air purging fails to effectively reduce it. See PTC section 4—TAS Service mode, Manual Operation—item 6, Hang-up Diagnosis.
- Connect the rpm pickup (arrow toward spark plug) to any plug wire if rpm is desired.
- Start the engine and bring it to normal idle speed and temperature.
- Insert the exhaust probe into the tailpipe.
- Press **Print** or the **Remote Button** to receive a copy of the screen values.
- Press **CONTINUE** to return to the Set-up screen.

COMBUSTION ANALYSIS

The internal combustion engine converts chemical energy stored in the fuel into heat energy. Heat increases the pressure within the engine cylinder by expanding the nitrogen in the air-fuel charge. The pressure of the nitrogen "working fluid" moves the piston and eventually the vehicle wheels.

The heat energy is released by simple combustion. Combustion is oxidation (burning) of the hydrocarbon fuel. This combustion process is the heart of engine operation. By understanding the nature of combustion and analyzing the gases left over from combustion the operator can evaluate engine performance.

Combustion Requirements

1. Induction of an air-fuel mixture that is of the proper ratio and quantity.
2. Engine mechanical integrity that enables perfect coordination of components and good sealing during compression and expansion.
3. Ignition that is correctly timed and develops good spark intensity and duration.

Engine systems try to meet these requirements under all operating conditions.

Ideal Combustion

In the laboratory, perfect combustion changes hydrocarbon fuel (HC) and air, nitrogen (N_2) plus oxygen (O_2), into carbon dioxide (CO_2) and water (H_20). To do this, the fuel separates into hydrogen and carbon while combining with the air's oxygen. If ideal combustion conditions are maintained, all of the ingredients are converted to desirable byproducts while releasing a great amount of heat (Fig. 1)

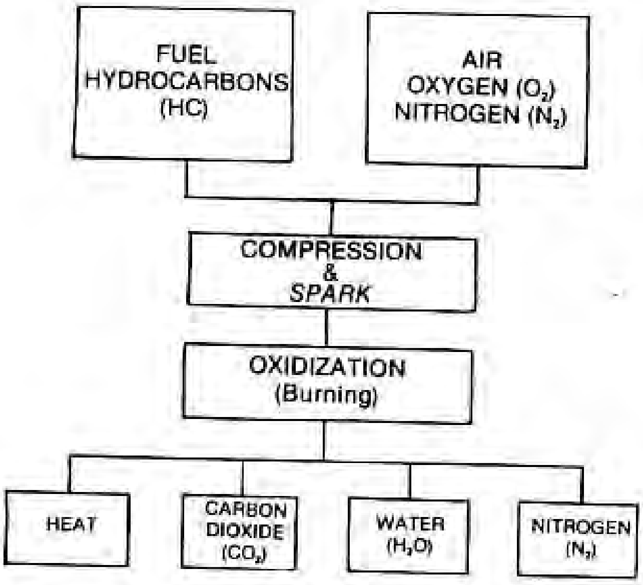


Figure 1: Perfect Combustion

Realistic Combustion

Unfortunately, perfect combustion happens consistently only in the laboratory. Even computerized engine control systems do not precisely satisfy all engine operating requirements during all operating situations. When poor combustion occurs, the vehicle exhaust contains excessive leftover ingredients and pollutants.

Three major gaseous pollutants emitted from the engine are hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). In addition, the exhaust contains a trace amount of sulfur oxides (SOx), and particulates such as lead, carbon, and sulfur.

The byproducts CO_2 and H_2O, and the unused ingredients O_2 and N_2 are not considered pollutants but are important as indicators of combustion quality. Of these, CO_2 and O_2 are commonly used to analyze engine system performance.

Realistically, the engine exhaust (Fig. 2) contains varying amounts of desirable byproducts, pollutants, and unused ingredients. Understanding the nature of these exhaust emissions is the key to infrared analysis.

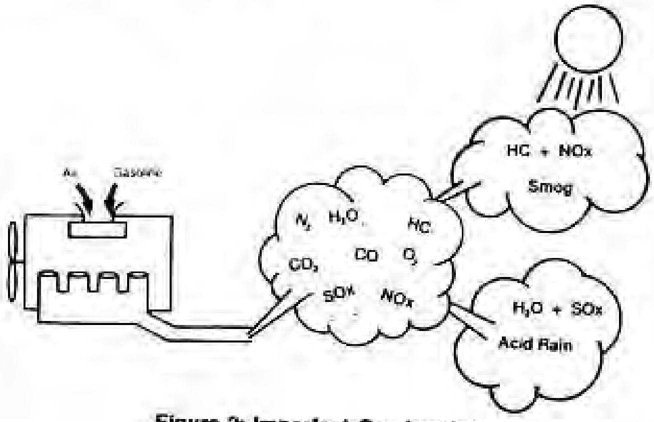


Figure 2: Imperfect Combustion

Stoichiometry

Combustion is most efficient, with regards to pollution and economy, when the air and fuel are mixed at a ratio of 14.7 lbs. of air to 1 lb. of fuel (14.7:1). This chemically ideal air fuel ratio (AFR) is called "stoichiometric"—hydrogen and carbon combines with the oxygen to produce maximum H_2O, CO_2, and heat. Also this AFR is the best compromise for efficient operation of three gas catalytic converters. Modern automotive fuel systems strive to maintain a stoichiometric AFR under all engine operating conditions.

EXHAUST GASES

Lets look at the gases of major interest (CO, HC, CO_2, and O_2) to see how they form during combustion and relate to exhaust analysis. This information is the foundation for accurate testing and diagnosis.

Hydrocarbons (HC)

Hydrocarbons, measured is parts per million (ppm), contribute to air pollution. When sunny, still air conditions exist; HC combines with oxides of nitrogen (NOx) to form photo chemical smog. High HC in the exhaust is caused by fuel that was not oxidized (burned) during combustion. Depending on the ppm, this can indicate moderately rich air-fuel ratios, or misfiring do to major air-fuel quality or ignition problems.

When the AFR is too rich, there is not enough O_2 available to convert all the HC into H_2O and CO_2. This leaves unburned HC.

When the air-fuel charge is excessively lean or contains too much exhaust gas, the HC molecules are spaced too far apart for normal flame propagation. Lean misfires (Fig. 3) and exhaust gas related misfires are more common than rich ones.

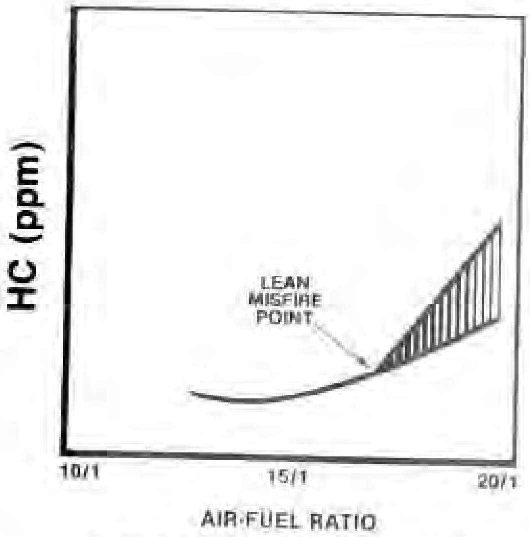


Figure 3: Lean Misfire & Unused HC

The most noticeable HC increase occurs when poor spark production or delivery causes one or more cylinders to misfire (Fig. 4). Electrical misfire will cause a dramatic (400 ppm to full scale) rise in HC emissions. Therefore, HC is an excellent indicator of ignition problems.

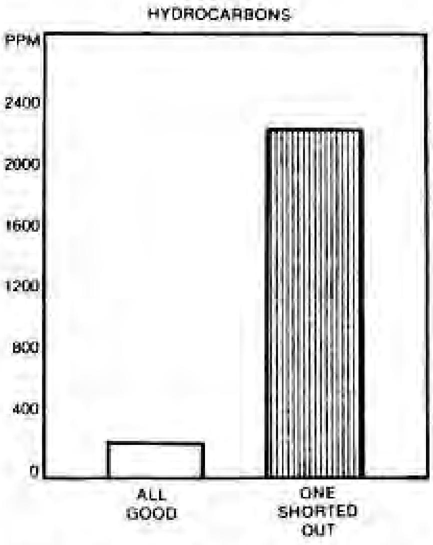


Figure 4: Spark Plug Misfire & Unused HC

Carbon Monoxide (CO)

Carbon Monoxide, measured in % by volume, is a pollutant produced by partial combustion. It forms when one carbon from the HC combines with only one oxygen. CO is an oxygen-hungry compound that upon release to the environment will eventually attract another oxygen molecule to become CO_2.

When the AFR is richer than 14.7:1, the CO production increases—there is an oxygen shortage per carbon.

When the AFR is leaner than 14.7:1, CO decreases—there is plenty of O_2 per carbon and available carbons usually join two oxygens to produce CO_2. Figure 5 shows CO production decreasing as AFR gets leaner.

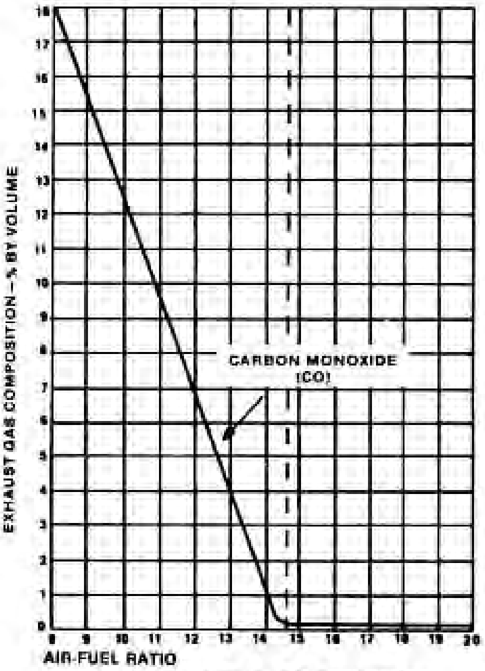


Figure 5: AFR & CO Production

It should be noted that some form of spark must occur to make conditions possible for the production of CO. However, HC is a better indicator of ignition problems than CO. CO is best used as an indicator of AFR related problems because of its sensitivity to mixture changes, especially on the *rich* side of 14.7:1 (Fig. 5).

Carbon Dioxide (CO_2)

Carbon Dioxide is measured in % by volume, and is a desirable combustion byproduct. CO_2 production is highest when the carbon and oxygen availability are balanced and the engine is operating efficiently. CO_2 is a good indicator of combustion efficiency.

CO_2 production will decrease when the AFR is richer or leaner than the optimum 14.7:1 ratio (Fig. 6). Thus, CO_2 can be used to indicate stoichiometric AFR.

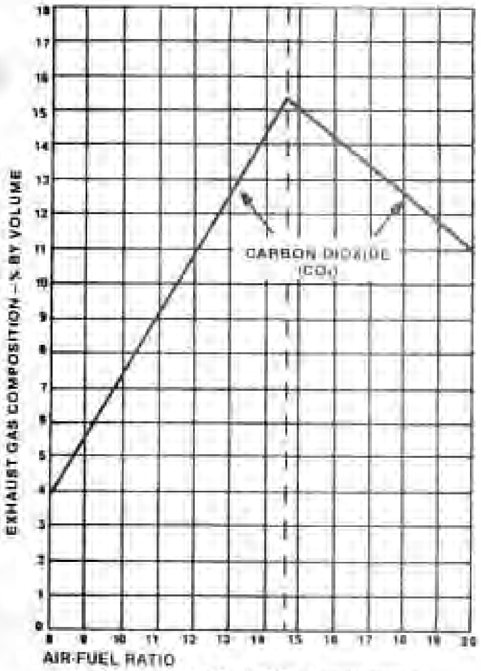


Figure 6: AFR & CO_2 Production

When the AFR is richer than 14.7:1, there is an oxygen shortage per carbon—this causes only one oxygen to join the carbon (CO) instead of two (CO_2).

When the AFR is leaner than 14.7:1, a carbon shortage per oxygen exist. There is enough oxygen to convert the carbon to CO_2, but not much carbon is available.

Any AFR, ignition, or mechanical problem that degrades combustion efficiency will cause a reduction in CO_2.

Oxygen (O_2)

Oxygen is measured in % by volume and is a necessary ingredient of the combustion process. About 21% of the atmosphere at sea level is occupied by O_2. The O_2 level at the tailpipe depends on the amount delivered to the cylinders and exhaust system (air injection), and the amount used for combustion.

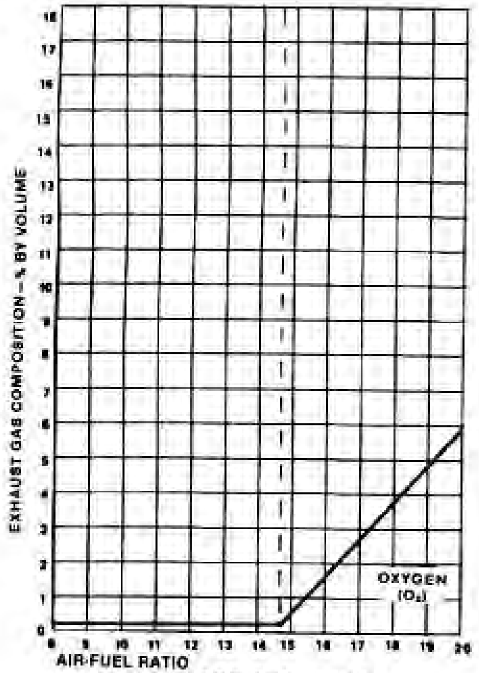


Figure 7: AFR & Unused O_2

At each AFR leaner than 14.7:1 the exhaust O_2 level increases sharply (Fig. 7). This occurs because the O_2 supply has increased while the demand has decreased (less fuel to be converted to CO, CO_2, and H_2O). O_2 is a good indicator of a lean AFR because it increases when other gases are decreasing to a barely detectable level.

Poor combustion, caused by a cylinder with a lean or ignition misfire, will release plenty of unused O_2. This is especially true with four cylinder engines. The per cylinder contribution of a four cylinder engine is about twice that of an eight cylinder engine. The leftover O_2 can ignite the converter, even with the air injection disabled, and reduce the HC to quite a low level.

Insufficient probe insertion, enabled air injection, and air leaks into the vehicle exhaust system or the analyzer sample system can dilute the gas sample and cause high O_2 readings. Stop these sources of O_2 for valid test results.

GAS ANALYSIS TIPS

When evaluating exhaust gas readings, consider the following items.

- Amount: Is the gas value higher or lower than normal?
- Stability: Is the gas value steady or does it vary at a given engine speed?
- Repeatability: Upon return to idle from cruise, is the gas value the same as before?
- Correlation: Is an abnormal reading obvious only during a certain operating condition like idle, transition, cruise, power, etc.
- Sample quality: Is the gas sample masked by the converter, air injection, or a leaking exhaust; or does it represent true combustion gases.
- Gas sensitivity: All gases may respond to a particular combustion or emission control problem. However, it is better to evaluate each gas for the type of problem it is most sensitive to.

Gas Log

Precise exhaust gas values are useful to diagnose performance problems with a specific vehicle. Normal gas values can vary greatly depending on the year, manufacturer, model, equipment options, emission controls, and operating environment. The values given in this book are general in nature and attempt to define typical situations that are likely to occur. For more accurate diagnosis, maintain a gas log that shows normal values for each vehicle listed. The log can be categorized by the year, manufacturer, model, emission control equipment etc.

Catalytic Converters

With the proper supply of oxygen and adequate warm-up time, an oxidation converter can reduce HC and CO to a barely detectable level at the tailpipe. To combat this problem, disable the air injection and try one of the following options.

- If the vehicle has a removable plug upstream of the converter, sample the gases there.
- Stop the engine and allow the converter to cool 10 minutes. Restart the engine and complete the test quickly (2 minutes) before the converter has a chance to relight.

General Tips

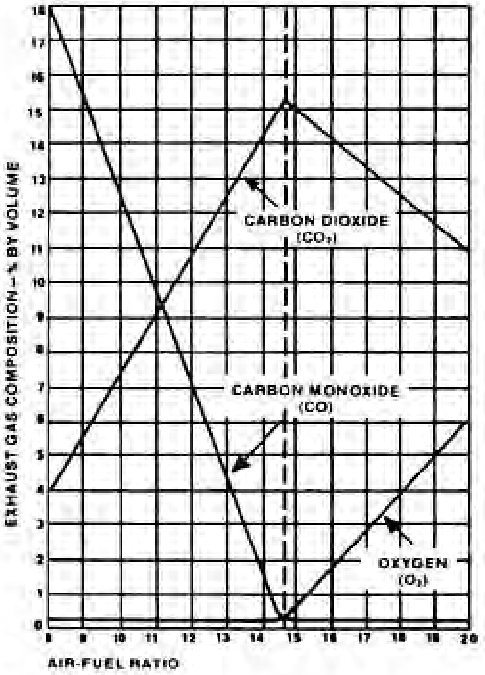
- A catalytic converter that is not active can give gas readings like a non converted engine.
- Any HC reading 1000 PPM or above indicates a severe misfiring problem.
- Unstable CO readings indicate AFR problems.
- Bad fuel distribution can cause high unstable HC readings, normal to high CO readings, and low CO_2 readings.
- Unstable HC and CO_2 readings can indicate intermittent misfiring problems.
- Small air leaks become less significant at higher RPMs.
- A lean misfire problem can cause the RPM to increase 10% or more during artificial enrichment.
- Combustion efficiency increases with throttle opening. This causes HC and CO to reduce up to 50% while CO_2 increases.

TESTING AND DIAGNOSIS

The following tests use exhaust gas and rpm to identify problem areas. The previous topics on Combustion, Exhaust Gas, and Gas Analysis Tips will aid the technician in performing these tests.

Locating an Exhaust System Air Leak

Use the Leak Test to identify air leaks into the vehicle exhaust system. Air leaks will cause sample dilution and invalid test results.



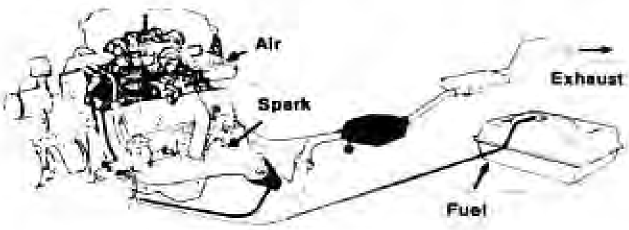
If engine performance is smooth, and HC is low, the sum of the CO and CO_2 readings should be less than 7 or 8%—if more, dilution is indicated. During efficient combustion, the chemical interrelationship of the exhaust gases shows it is unlikely an engine could operate at the AFR required (22:1) to produce a CO + CO_2 sum of 7 or 8%.

PROCEDURE

1. Disable the air injection system.
2. Insert the probe at least 12 inches into the tailpipe.
3. Start the engine and record the gas values.
   - Add the values of the CO and CO_2. If the sum is less than 7% and the HC is quite low, dilution is indicated.
   - If the O_2 value is high (4-12%) and the engine idle quality is good, dilution is indicated.
4. Return the air injection system to its pretest status.
5. Repair and retest the vehicle.

Dead Engine Test

Use the dead engine test to identify the system (air-fuel metering, ignition, or compression) causing a no-start problem. This test checks the exhaust to verify that fuel is being delivered to and pumped through the engine cylinders during cranking.



PROCEDURE

1. Insert the exhaust probe at least 12 inches into the tailpipe.
2. Partially block the air horn with your hand and crank the engine for several seconds. Feel for a strong vacuum and record the HC value.
   - If the HC value is high (1600-2000) and the vacuum is strong, fuel is available and the engine has the mechanical integrity for pumping. Test for spark at the spark plug.
   - If the HC value is zero or very low and the vacuum is weak, verify spark to the plugs then check the engine for compression, large air leaks, and the condition of the valve train parts.
   - If the HC value is zero or very low and the vacuum is strong, activate the accelerator pump, fuel injectors, or cold start valve to check for fuel delivery.
3. Repair and retest.

For no fuel on injected vehicles, check:

- Pump safety switch
- Oil pressure switch
- No rpm signal.
- Pressure regulator.
- Pump, filters, or relay.

Locating a Fuel Leak

If the vehicle has a fuel odor or poor mileage, use the exhaust probe to trace the fuel system and locate leaks.

PROCEDURE

1. Start the engine and raise the vehicle a few feet.
2. Use the exhaust probe to trace the fuel tank, lines, pump, filter, etc.
3. Note any change in the HC value.
   - The HC will increase as the probe approaches the leak.
4. Repair and retest.

Locating Vacuum Leaks

Air leaks into the intake manifold can cause poor idle quality and surging. Low CO and high unstable HC are symptoms of a lean misfire. When propane is injected into an air leak, the gas values and idle quality will improve.

PROCEDURE

1. Disable the EGR valve, air injection, and closed loop system.
2. Note the rpm and gas values.
3. Trace around suspected air leaks with the hose from a propane enrichment tool. Make sure to check all gaskets, hoses, and diaphragms that must hold vacuum.
4. Note the rpm and gas values.
   - When a leak is located the idle quality will improve, rpm and CO increase, and HC decrease.
   - If no vacuum leak is found and the engine still idles poorly, test the EGR system.

Exhaust Leaks into the Passenger Cabin

Air cooled engines obtain passenger heat from a heat exchanger within the vehicle exhaust system. If the exhaust system leaks into the heat exchanger, the heater ducts can deliver lethal carbon monoxide into the passenger compartment.

PROCEDURE

1. Note HC and CO readings with the probe sampling room air.
2. Open one window slightly and bring the probe into the passenger compartment.
3. Start the engine and turn on the heater and blower controls.
4. Insert the probe into heater and defroster outlets to check for HC and CO.
   - Any increase indicates an exhaust leak.
5. Repair and retest.

Air Injection System Test

The air injection system pumps fresh air into the exhaust system at a point where the exhaust gases are still very hot. This provides O_2 for extended combustion of the exhaust gases. Some systems can switch the air flow into the converter or upstream. When the air injection system is disabled, the exhaust emissions will show a noticeable change if the system works properly.

PROCEDURE

1. Warm the engine and note the gas values with the air injection system enabled.
2. Disable the air injection and note the gas values. Injection systems can be mechanically or electrically disabled, depending on their design.
   - A significant reduction in O_2 and an increase in the HC and CO should occur when the system is disabled.

Catalytic Converter Efficiency Test

Oxidation converters change CO and HC into CO_2 and H_20. When combustion is efficient, the exhaust O_2 is sufficient, and the converter is good; the CO and HC emissions are nearly zero. When combustion in a cylinder is temporarily stopped, a good converter should have the capacity to clean up nearly all the additional HC from the dead cylinder.

PROCEDURE

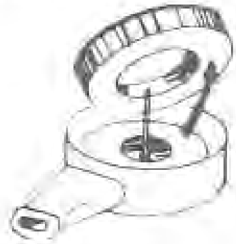
1. Start the engine and allow a ten minute warm-up to activate the converter.
2. Verify that the air injection is on.
3. Verify that the CO is less than 1% and the HC is less than 200 ppm.
4. Interrupt the ignition to one spark plug for ten seconds or less.
5. Note the gas values.
   - The converter should be able to oxidize most of the HC from the dead cylinder.
   - The HC value should be less than 800 ppm if the converter is operating properly.
   - During ignition interruption, four cylinder engines can have higher readings than six or eight cylinder engines because their per cylinder contribution is greater.
6. Repair and retest.

Air Filter Test

An air cleaner with a dirty filter element will restrict the air flow to the intake manifold and cause a rich mixture. The filter element can look good when backlighted by a shop light yet still restrict the air flow, especially at higher engine rpms. The filter test compares the gas values taken at cruise speed with the filter installed and removed.

PROCEDURE

1. Set the engine speed at a steady 2000 rpm.
2. Record the gas values with the filter and housing assembled.
3. Remove the filter and install the housing lid.



4. Record the gas values.
   - The gas values with the filter out should match those with the filter installed. If the CO drops with the filter out, it indicates more O_2 is available then—replace the filter.

PCV Valve Test

The PCV valve meters crankcase vapors into the intake manifold to be burned. These vapors are a result of cylinder blow-by and would otherwise accumulate in the crankcase and cause engine damage.

Most engines today have a positive-flow closed-loop ventilating system. This system uses manifold vacuum to move filtered air through the crankcase to purge the vapors. The vapors usually exit the engine at the valve cover and are routed to the intake manifold and combustion chamber, completing the loop. A malfunction in this system can greatly affect the air-fuel mixture.

This test will verify that PCV system is operating by checking the flow and gas values with the valve isolated from the crankcase.

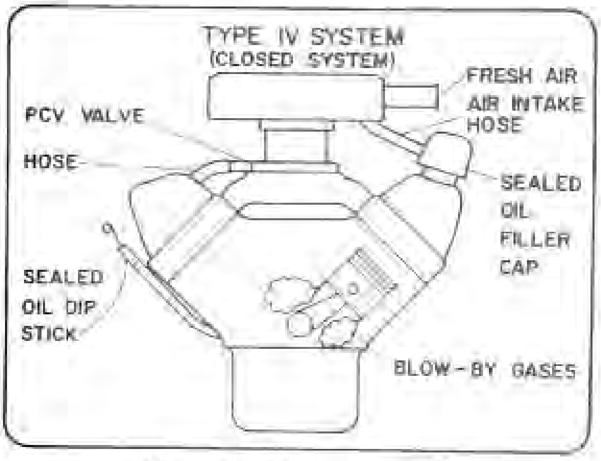
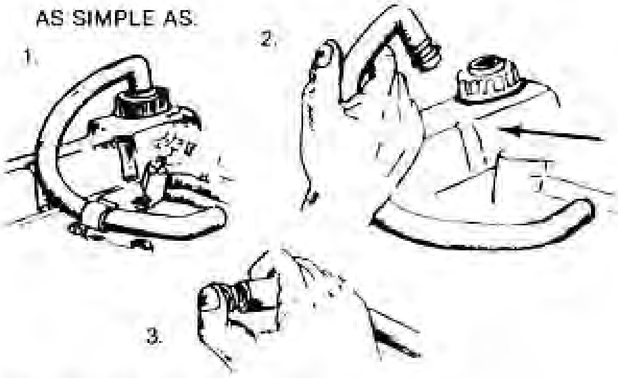


Figure 8 — PCV system

PROCEDURE

1. Start the engine and note the rpm and gas values when they stabilize.
2. Disconnect the PCV valve from the engine so the valve can meter fresh air.



3. Note the rpm and gas values.
   - The CO should drop 1-1.5% when the valve is open to air making the AFR slightly leaner. The HC reading may become unstable if a lean misfire begins.
   - If no change is noticed, the valve or plumbing could be clogged.
   - If the CO value is reduced more than 1.5%, it indicates excessively rich crankcase vapors and fuel contaminated oil. Repair the contamination source and change the engine oil. Fuel in the crankcase can damage the engine and makes idle mixture adjustment inaccurate.

For contamination check for:

- Prolonged cylinder misfire
- Malfunctioning fuel evaporation system (sucks raw fuel into intake manifold).
- Sunken float or leaky needle and seat.
- Short trip driving (engine doesn't reach a desirable temperature).
- Leaky fuel pump (can drip gasoline directly into the crankcase).
- Choke opening improperly.
- Leaking fuel injector.
- Leaking cold start valve.
- Defective fuel pump, or pressure regulator on fuel injection systems.

4. Block the valve with your thumb and note the suction and rpm.
   - No suction can indicate a plugged system.
   - The engine speed should drop 50-150 rpm. If the rpm increases and the idle quality improves, an excessively lean AFR is indicated.

For lean misfire check:

- Air leaks.
- PCV valve for wrong flow rate.

PCV System Flow Test

The vacuum at the PCV valve can feel strong as the vacuum builds under your thumb, however, the flow should also be tested. A restriction in the system can cause engine blow-by to exceed the system's designed flow rate during engine loading. This will cause excessive oil and vapors to exit via the air inlet for the PCV system. Use a 3x5 card to test the flow at the air cleaner end of the fresh air hose.

PROCEDURE

1. Separate the fresh air hose from the air cleaner housing, then start the engine.
2. With the engine at idle, hold a 3x5 card close to the end of the hose.
   - The flow should draw the card to the end of the hose, the vacuum should hold it there.

If the card falls off, check for:

- Air leaks between the PCV valve and air inlet. This includes engine gaskets and seals.
- System restrictions.
- Too much engine blow-by.

EGR Valve Test

The exhaust gas recirculation (EGR) valve opens a passage to meter a small amount of exhaust gas into the intake manifold. If the combustion is efficient, the exhaust gas contains very little HC or O_2 and has little effect upon the air-fuel ratio. It merely takes space normally occupied by the air-fuel charge. With less air-fuel charge to burn, the heat of combustion is cooler, producing less NOx emissions.

The exhaust gas entering the cylinder must be metered in proportion to the air-fuel charge. Too little gas causes increased heat and NOx. Too much causes poor flame propagation (travel) because there is not enough air-fuel charge to bridge the exhaust gas molecules. This causes misfires.

Misfires caused by exhaust gas are similar to misfires caused by lean AFR in that the engine is likely to idle rough or surge at cruise. Artificial enrichment (adding fuel) of a lean misfire will improve idle quality and reduce HC emissions because it improves AFR. Artificial enrichment of an exhaust gas related misfire is less likely to improve idle quality or reduce HC emissions because the problem is associated with not enough air-fuel charge rather than ratio of the air-fuel charge. Adding HC without adding O_2 may only complicate the problem by causing excessive richness.

The exhaust gas entering the cylinder must also suit the engine operating conditions. Most gasoline engines will tolerate EGR at part throttle acceleration and cruising under moderate load conditions—engine operating quality is less likely to suffer then. Few engines use EGR at idle—they breathe poorly then. Nor do they during cold operation—more air-fuel charge is needed to offset poor fuel vaporization and suspension. At wide open throttle (WOT), EGR is generally by-passed for best power conditions of high air-fuel density.

The EGR valve operates as the throttle plate opens. Carburetor ported vacuum (above throttle) is applied to the top of the EGR diaphragm. Ported vacuum overcomes the EGR closing spring and the valve opens (Fig. 9). This vacuum makes the EGR valve sensitive to throttle position and engine load. Closed throttle and heavy loads reduce vacuum to the valve.

Some EGR valves incorporate a backpressure sensor. Ported vacuum is bled off until exhaust back pressure reaches a specified amount. This makes the valve sensitive to exhaust restrictions.

EGR valve cold operation is controlled by temperature sensitive vacuum switches, or by the on-board computer and vacuum solenoid.

Leaky EGR systems can cause lean AFR or exhaust gas related misfires. Use the Internal and External leak test to identify which.

Internal leak test—gas misfire

EGR systems that direct exhaust gases at idle can exhibit engine performance symptoms similar to those associated with vacuum leaks and lean misfiring. The engine idles roughly and HC levels in the exhaust are high and wavering.

PROCEDURE

1. Start the engine and note gases, rpm, and idle quality.
2. Inject propane into the air horn to artificially enrich the AFR.
3. Note changes in gas, rpm and idle quality.

- If the idle quality is better and HC decreases, look for an air leak using the external leak test.
- If the idle quality and HC are about the same, look for an EGR related problem.

Check for:

- Stuck open EGR valve.
- Burned through passage.
- Improper vacuum source to valve.

4. Repair and retest.

Exhaust gas related misfires can also be caused by valve train problems like sticking or leaky intake and exhaust valves, worn camshafts, and camshaft timing. These problems are likely to reduce the amount of AF charge entering the cylinder and/or increase the amount of exhaust gases left in the cylinder. Identify valve related problems using vacuum and rpm tests. Serious valve leaks will cause a steady pulse in the vacuum and rpm readings. An EGR problem makes the vacuum drift up and down with a random roughness or engine roll at idle.

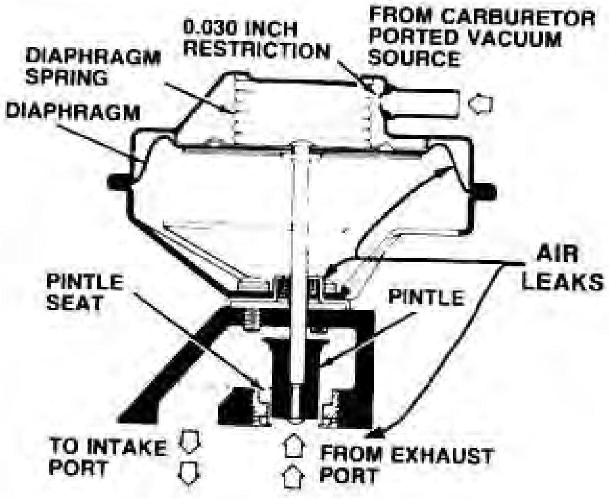


Figure 9.

External leak test—lean misfire

Another problem associated with EGR valves can be external air leaks into the intake manifold. These leaks can originate at the mounting surface, at cracked bases and diaphragms, or at the control rod for the diaphragm. This rod passes through a gasket and an intake manifold passage on its way to the pintle valve, Figure 9.

PROCEDURE

1. Start the engine and note gas, rpm, and idle quality.
2. Artificially enrich the environment around the EGR valve with propane by directing the hose at the desired location.
3. Note the change in gas, rpm, and idle quality.

- If the HC becomes stable and CO increases with improved idle quality, an air leak is indicated.

4. Repair and retest.

Accelerator Pump Test

A carburetor accelerator pump mechanically delivers a small spray of fuel during acceleration from idle to cruise. Mechanical delivery is needed because the heavier fuel cannot respond as quickly as the air when the throttle is opened. This fuel lag would cause a temporary lean spot and hesitation. The acceleration system can be checked by noting the gas values while jabbing the throttle.

PROCEDURE

1. Set the engine speed at fast idle, approximately 1200 RPM.
2. Note the gas values after they stabilize.
3. Quickly jab the throttle without raising the engine rpm.

4. Note the CO and HC readings.

- If the fuel delivery is about right, the CO will increase at the same time or slightly ahead of the HC. The CO should increase 1% over the original reading. The HC should increase up to 600 ppm.
- If the fuel delivery is too little, the engine can hesitate, the HC can respond before the CO, and the CO may even decrease.

Check for:

- Fuel spray by opening the throttle.
- Bent or misadjusted linkage.
- A stuck plunger.
- A defective inlet or outlet check valve.
- A cracked plunger or diaphragm.

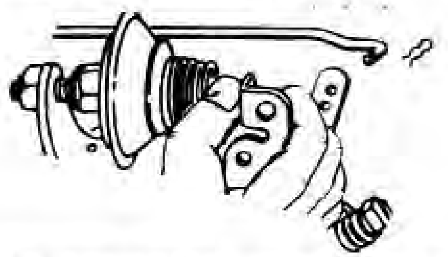
Power Valve Test

The power valve opens to supplement main metering fuel delivery. A richer AFR allows all the oxygen in the combustion chamber to be used, and develops maximum power. When the intake manifold vacuum decreases the power valve opens. Valve operation can be checked by jabbing the throttle, to drop the vacuum, and noting the gas values.

It is important to verify the power valve opens and closes. If the valve fails to open, the engine can surge and hesitate. If it fails to close, poor fuel mileage and rough idle occurs.

PROCEDURE

1. Disconnect the accelerator pump linkage.
2. Use the fast idle cam to block the throttle at 1500 rpm. Note the gas values when stable.



3. While holding the fast idle cam in one hand, quickly open and return the throttle to the same cam position.

   It is important to return to the same fast idle cam setting in order to check for proper reseating of the power valve. This test may be repeated several times to check for consistency.

- The CO should momentarily increase (1-2%), then return to the original reading.

Cylinder Power and Balance Test

For good combustion each cylinder needs the proper air-fuel ratio, good mechanical integrity to provide proper sealing during compression and expansion, and ignition that is correctly timed and develops good spark voltage and duration. When these needs are properly fulfilled, all cylinders deliver equal and adequate power.

When combustion is stopped in a cylinder by interrupting the ignition, the change in rpm and exhaust gas values can be analyzed to evaluate the cylinder's power contribution. All cylinders should show the same change when killed. A weak cylinder will show very little rpm loss, or it could show a gain. A misfiring cylinder will contribute very little additional HC during ignition interruption. Depending on the nature of a problem, one cylinder or a group of related (companion) cylinders could be affected.

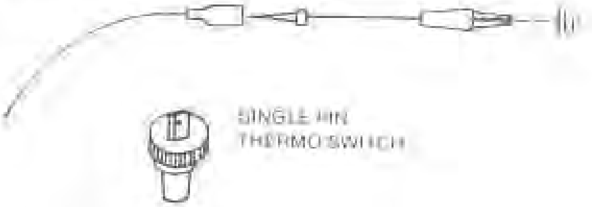
To ensure a valid cylinder power test, all other factors affecting the engine's operating status must remain steady-state. That way, only the dead cylinder is affecting the rpm and gas values. A change in spark or air-fuel mixture by electronic engine control systems, or a change in engine load by engine driven accessories will affect rpm and gas values, and may cause an invalid diagnosis.

TEST PREPARATION

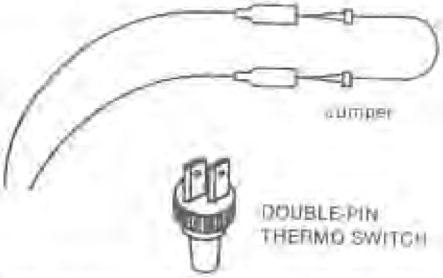
1. Disable the EGR valve to ensure even manifold distribution of the air-fuel charge. Block the vacuum to the EGR valve, or electrically disable the vacuum solenoid.
2. Electrically enable the engine's cooling fan motor to run continuously. This prevents intermittent electrical loading of the engine.

   Fan circuit designs will vary. However, they all have a thermo-switch to sense engine temperature. This switch can complete the motor circuit, energize a relay, or signal a computer that controls the fan motor. Generally, the easiest place to enable the fan motor is at the thermo-switch. Separate the harness at the thermo-switch and use one of the following options to allow the fan to energize when the key is turned on.

- A few fans are enabled when the harness is removed from the thermo-switch. Try this method first.
- If the thermo-switch has a single terminal, use a jumper wire to ground the harness.



- If the thermo-switch has a double terminal, use a test light to check if both wires in the harness are hot (+). If they are, use a jumper to ground one of the harness wires. If only one is hot, the other is likely to be ground—join the two harness wires with a jumper wire.



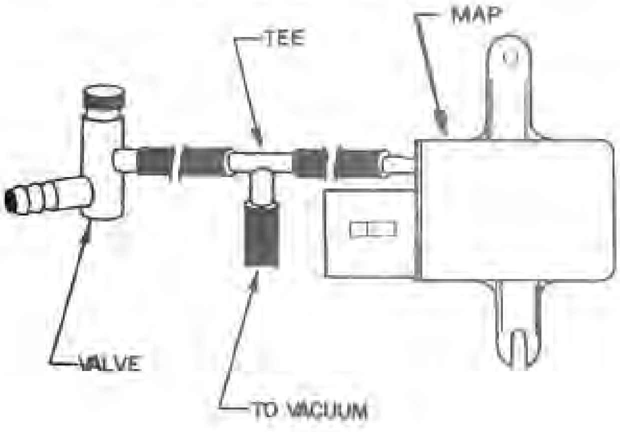
If the thermo-switch is hard to access, the operator may want to energized the fan at the motor terminal once the harness is removed.

- For a motor with one terminal, use a jumper wire to apply battery plus (+) to the motor terminal.
- For a motor with two terminals, apply battery plus (+) to one motor terminal to see if the motor will run. If the motor fails to run, apply battery minus (-) to the other terminal.

3. Disable full-time air conditioning systems to ensure stable rpm. Disconnect the harness from the compressor clutch.
4. Disable the air injection system to help deactivate the converter and make the gas values easier to read.
5. Electronic engine control systems (closed loop, feedback, etc.) can change throttle position, idle bypass air, AFR, or timing during cylinder kill. Disable electronic engine control system to ensure a valid power analysis.

Ford systems with a MAP sensor

- Locate the MAP sensor and introduce a small vacuum leak (use an aquarium valve) to lower the vacuum. Open the valve slowly until the vacuum is 7-12 inches of mercury or until the rpm rise and stabilize.

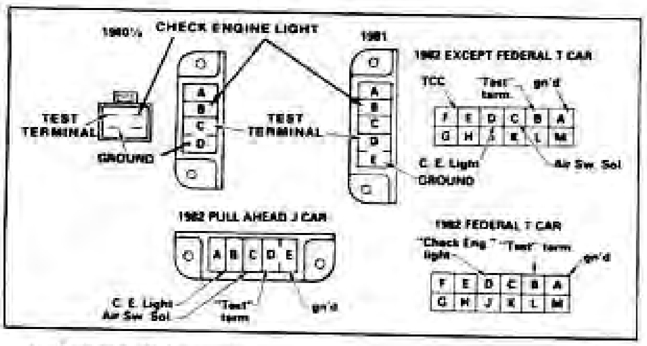


Ford systems without a MAP sensor:

- Disconnect the O_2 sensor.

GM Closed Loop Carbureted systems: (CCC, Min T)

- Turn the key off and disconnect the O_2 sensor.
- Short between the Ground terminal and the Test terminal at the ALDL connector.



- Restart the engine.

GM Close Loop Fuel Injected systems: (TBI, PFI)

- Slowly bleed off vacuum (use an aquarium valve) to the MAP sensor until the rpm rise and stabilize.

Other systems:

- Most closed loop systems can be disabled by turning off the engine, disconnecting the O_2 sensor, then proceeding with the test.

TEST CONSIDERATIONS

The rpm and gas values recorded at idle and cruise should be evaluated for:

- Amount: Are the values low, normal or high?
- Equality: Are all the values the same?
- Correlation: Is there anything common only to abnormal reading cylinders? Like the same intake plenum or the EGR is located closer. Is an abnormal reading obvious only during a specific operating condition like idle, or cruise?

Given enough oxygen and warm-up time, the oxidation converter can make the gas sample unstable and difficult to evaluate. Disabling the air injection may not keep the O_2 level low enough to obtain a valid gas sample. If a cylinder is currently misfiring, or the ignition is interrupted longer than a few seconds, the O_2 from the dead cylinder can be enough to intermittenly ignite the converter.

When the idle quality indicates a misfire, yet the HC value is low; use rpm drop to evaluate the cylinders. If no misfire is suspected, use gas and rpm for analysis. Kill the cylinder for less than 10 seconds and wait 30 seconds between kills to allow the O_2 to purge from the system.

Artificial enrichment of the AFR with propane may also counteract high O_2 in the exhaust and keep the converter extinguished. Prior to testing, enrich the mixture until the CO is 3%. Keep the valve at the same setting during testing. Enrich at the air intake, to ensure even distribution. Even though the AFR is enriched and the readings abnormal, the change in rpm and gas values can be compared to evaluate the cylinder's power contribution. Again it is important to kill for only a few seconds and allow time between each kill to purge the unused oxygen. If rpm, idle quality, and exhaust gases improve when enrichment begins; a lean misfire should be suspected.

PROCEDURE

1. Enable or disable the appropriate systems to prepare the vehicle for the cylinder power test.
2. Set engine speed to 1000-1200 RPM.
3. Kill the cylinders in any order but record the change in rpm and gas values in the idle test box that corresponds to the cylinder number.
4. Set engine speed at 2300-3000 rpm.
5. Repeat step 3 but record the values in cruise test boxes.

	Rank	1st	2nd	3rd	4th	5th	6th	7th	8th
	Firing Order								
Idle	RPM								
	HC								
	CO								
	CO_2								
	O_2								
Cruise	RPM								
	HC								
	CO								
	CO_2								
	O_2								

- A slight HC increase (400-800 ppm) can be expected from each cylinder that is killed.
- The HC can increase 800 ppm to full scale if:

  The vehicle has no oxidation converter.

  The gases are sampled upstream of the converter.

  The oxidation converter is damaged.

  The converter efficiency is reduced because the oxygen level is too low or the warm-up time was too short.
- The rpm should decrease an equal and adequate amount for each cylinder. An eight cylinder engine will provide a 6-7% rpm drop; a six cylinder, 8-9%, and a four cylinder, 12-14% drop.

HC EMISSIONS	LIKELY PROBLEM
1. Every other cylinder reads higher than the average.	Unbalanced carburetor, carburetor base or manifold air leak.
2. Two cylinders on the same intake runner read low.	Vacuum leak, check for hoses off, intake manifold leak.
3. One or two cylinders low.	Sticky or poorly seated valve, intake manifold restriction. Intake manifold restriction will likely be true at higher RPM as well. A sticky valve may show normal at high RPM.
4. All cylinders reading equal but RPM reading low on some cylinders.	Not related to fuel, check scope for ignition. If OK, check compression.

Use the following chart to compare low and high speed readings. Depending on engine performance, these readings will respond in a predictable way.

SPEED	RPM CHANGE	HC INCREASE	LIKELY PROBLEM
LOW SPEED	LOW TO EQUAL	LOW	AIR LEAK
HIGH SPEED	EQUAL	EQUAL	
LOW SPEED	LOW	LOW	VALVE OPENING OR RESTRICTION, COMPRESSION
HIGH SPEED	LOW	LOW	
LOW SPEED	EQUAL	ALL HIGH	EXTREMELY RICH CARBURETOR SETTING
HIGH SPEED	EQUAL	ALL HIGH	
LOW SPEED	EQUAL	ALTERNATE HIGH/LOW	UNBAL CARBURETOR
HIGH SPEED	EQUAL	ALTERNATE HIGH/LOW	
LOW SPEED	EQUAL	EQUAL	OK
HIGH SPEEDS	EQUAL	EQUAL	

Air-Fuel Metering Performance

The air-fuel metering system must be able to compensate for changing engine operating conditions. This ensures that the cylinders will receive the proper air-fuel charge for economy, power, and emissions. The system performance can be tested when throttle position or engine load is changed to simulate driving conditions.

PROCEDURE

1. Disable the air injection system.
2. Start the engine and allow the engine to idle.
3. Note the rpm and gas readings.
   - The idle quality should be smooth and the rpm within the manufactures specs.
   - The gas values should be normal and stable.
4. Set the engine speed at 2500 rpm and note the gas readings.
   - The HC and CO should decrease while the CO_2 increases. This is due to better combustion efficiency.
   - A rich condition will cause the CO to increase while the HC remains about the same or only slightly lower.
   - A lean misfire will cause high HC and O_2 , and low CO and CO_2.
5. Release the throttle to allow the engine to idle. Then note the rpm and gas values. This step should be repeated several times to verify valid results.
   - The rpm and gas values noted in step 3 should recur if the air-fuel metering is consistent.

Idle Mixture Adjustments

Idle mixture adjustment procedures differ according to the manufacturer and vehicle features. They are designed to abide by the law while complimenting the engine systems, emission controls, and available test equipment. Currently these procedures are similar and observe either rpm or exhaust gases to indicate achievement of proper AFR. The mixture screws are adjusted until:

- The rpm is affected a specific amount by propane enrichment.
- A specific gas value is reached.
- The peak rpm or gas value is attained.
- Slightly less than peak rpm or gas value is attained.

The manufacturer's adjustment procedure will give the best results, however, the following simplified procedures may work satisfactorily.

PROCEDURE—PEAK CO_2 METHOD

1. Disable Air Injection
2. Start engine, bring to operating temperature.
3. Verify that the idle quality is good and the gas values stable.
4. Lightly bottom the idle mixture screws and back them out 2 full turns.
5. Adjust curb idle speed according to the manufacturer.
6. Turn the idle mixture screws 1/8 turn at a time in the same direction until the CO_2 reaches the highest value (usually 12-15%).
7. Adjust the mixture screws equally to the leanest setting possible while maintaining the peak CO_2 value, stable readings, and good idle quality. The HC should be stable and below 400 ppm, the C0 should be .5-3%.
8. Reset curb idle speed as needed.

PROCEDURE—PROPANE ENRICHMENT METHOD

Idle mixture can be checked by injecting a controlled amount of propane into the induction air and note its affect on engine speed. Some manufacturers set curb idle speed, then note the amount of rpm gain during enrichment. Others set engine speed during enrichment to an enriched idle specification, then note if the rpm drops to the curb idle speed specification when enrichment is stopped. Use the following generic procedure to check and adjust idle mixture.

1. Follow safety precautions and prepare the vehicle for idle mixture adjustment using propane. The pretest steps are usually listed on the tune-up decal. Be sure the transmission is in the proper gear.
2. Artificially enrich the mixture for highest rpm. Meter the propane into the air horn so it is evenly distributed to all the intake manifold runners. Increase enrichment slowly so rpm change is easily observed. If the propane flow is increased too fast the peak rpm will be missed because the engine becomes instantly rich—false test conclusions will result.
   - When the engine is currently too rich, adding any propane will reduce rpm. If this occurs stop enrichment, adjust the idle speed screw to the enriched rpm specification (step 3), then turn the mixture screws leaner until the curb idle speed specification is reached (step 5). Then repeat steps 1-6.
3. With the engine at peak rpm (propane may be flowing), and the transmission in the proper gear, adjust the idle speed screw to the enriched rpm specification found on the tune-up decal.

   If the vehicle decal only list rpm gain, add the rpm gain and curb idle specifications to calculate the enriched rpm specification.
4. Turn off the propane, place the car in neutral, and purge the system at 2,000 rpm for 30 seconds.
5. Place the transmission in the proper gear and check the curb idle speed.
   - If the curb idle speed is too low, the mixture screws are set too lean. Turn the mixture screws counterclockwise slowly and equally in 1/8 turn increments until curb idle speed is reached.
   - If the curb idle speed is too high, the mixture is too rich. Set the mixture leaner until the curb idle speed specification is attained.
6. Repeat steps 1-5 until the engine speed drops to curb idle specification when the propane is turned off.

PROCEDURE—LEAN DROP METHOD

This procedure adjust the mixture slightly leaner than the mixture needed attain peak rpm.

If the adjustment is not completed within three minutes, run the engine at 2000 rpm for one minute. This will purge and stabilize the system.

1. Adjust the curb idle speed.
2. Adjust the mixture screws slowly and equally in 1/8 turn increments until peak rpm is attained.
3. Lean the idle mixture screws equally until the rpm drops a total of 5%.
4. Adjust the curb idle speed. Do not use the mixture screws for this adjustment.

PROCEDURE—CO METHOD

This method can be used when the sample probe is inserted upstream of the converter, or the vehicle does not have a converter. Some vehicles provide a special upstream port to sample non converted gas.

1. Adjust the curb idle speed.
2. Adjust the mixture screws slowly and equally in 1/8 turn increments until the desired CO reading is attained. Verify that the idle quality is good and the gas readings stable.
   - Generally, 1-2% CO is acceptable for newer vehicles, and 2-3% for older vehicles.

     If the idle speed changes more than 5% while adjusting the mixture, reset the curb idle speed and repeat the mixture adjustment.
3. Adjust the curb idle speed.

GAS PARAMETER CHART

INFRARED ANALYSIS

EXHAUST GAS PARAMETERS FOR HC, CO, CO_2 & O_2

Gases	IDLE		1500 RPM		2500 RPM		Condition/ Possible Cause
	Converter*	Non-Converter	Converter*	Non-Converter	Converter*	Non-Converter	
HC (PPM) CO (%) CO_2 (%) O_2 (%)	0 - 150 1 - 1.5 10 - 12 .1 - 2.0	75 - 250 .5 - 3.0 10 - 12 .1 - 2.0	0 - 135 0 - 1.1 — .1 - 2.0	50 - 200 .5 - 2.0 — .1 - 2.0	0 - 75 0 - .8 11 - 13 .1 - 1.25	25 - 150 .1 - 1.5 4cyl - 3% 11 - 13 .1 - 2.0	NORMAL GAS READING — STABLE VALUES
HC (PPM) CO (%) CO_2 (%) O_2 (%)	0 - 150 Above 3.0 8 - 10 0 - .5	75 - 250 Above 4.0 8 - 10 0 - .5	0 - 135 Above 3.0 — 0 - .5	50 - 200 Above 3.5 — 0 - .5	0 - 75 Above 3.0 9 - 11 0 - .5	0 - 100 Above 3.0 9 - 11 0 - .5	RICH MIXTURE: Idle mixture too rich; choke set too rich or not opening fully; power valve leaking; float level too high; restricted air cleaner; PCV restricted; contaminated crankcase
HC (PPM) CO (%) CO_2 (%) O_2 (%)	0 - 150 0 - 1.0 8 - 10 1.5 - 3.0	75 - 250 0 - 1.0 8 - 10 1.5 - 3.0	0 - 135 0 - .8 — 1.0 - 2.5	50 - 200 0 - .9 — 1.0 - 2.5	0 - 75 0 - .25 9 - 11 1.0 - 2.0	0 - 100 0 - .75 9 - 11 1.0 - 2.0	LEAN MIXTURE: Low float level; idle mixture lean; cruise mixture lean; small air leaks; cracked or disconnected vacuum lines
HC (PPM) CO (%) CO_2 (%) O_2 (%)	50 - 850 0 - .3 5 - 9 4 - 9	400 - 1200 0 - .75 5 - 9 4 - 9	50 - 850 0 - .3 — 4 - 9	400 - 1200 0 - .75 — 2 - 7	50 - 750 0 - .3 6 - 10 2 - 7	400 - 1200 0 - .75 6 - 10 2 - 7	LEAN MISFIRE: Severe air leak; bad spark plug or wire; stuck PCV; misadjusted defective carb
HC (PPM) CO (%) CO_2 (%) O_2 (%)	50 - 850 .1 - 1.5 6 - 8 4 - 12	over 1,000** .5 - 3.0 6 - 8 5 - 12	50 - 850 0 - 1.1 — 4 - 12	over 1,000** .5 - 2.0 — 5 - 12	50 - 750 0 - .8 8 - 10 4 - 12	over 1,000** .1 - 1.5 8 - 10 5 - 12	MISFIRE: Overadvanced timing; fouled plug; open/grounded plug wire; EGR stuck open

*Converter readings are taken with the air injection system disabled.
**Maximum digital reading HC on Analyzer = 2000 PPM.

SECTION 3
SMART OR NETWORK DIAGNOSTIC MODE

This section covers the operation of the Smart and Network Diagnostic modes (depends on equipment features). Either mode performs a computer directed test that analyzes underhood performance, then displays and prints a diagnostic result with repair of adjustment recommendations.

When the EPA Test Analyzer System (TAS) is used as an independent module, Smart Diagnostics is used. Network Diagnostics may be used when a Smart Engine Analyzer (SEA) module is electronically interfaced (Networked) to communicate with an EPA/TAS module.

"Network Communication" marries the intelligence of the EPA/TAS and SEA modules. An electrical cable joins the microprocessors of each module via existing RS232 connectors. After entering simple screen selections communication is established and the "Network" is formed. This umbilical union of Allen modular Smart products gives birth to a Computer Test Center with five separate microprocessors, cooperating diagnostic systems, and the flexibility to conquer the challenge of tomorrow.

During Smart Diagnostics, emissions and rpm are used to analyze engine performance. However, in the Network Diagnostic mode the best features of the SEA and EPA/TAS modules are united to provide performance testing of the starting, charging, fuel/air management, compression, timing, and ignition systems. This all system testing approach is recommended for its speed and accuracy.

Either test can be used for before repair diagnosis, or for an after repair quality control check. The simplicity, speed, and accuracy of computerized analysis increases productivity. The diagnostic printout is a powerful sales tool that improves customer communication, confidence, and satisfaction.

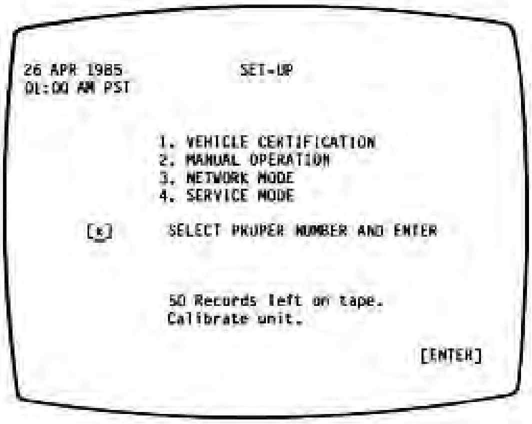
A diagnostic test is easy to perform because the analyzer will:

1. Direct the operator's tasks with screen prompts.
2. Select performance standards for the vehicle.
3. Monitor exhaust gas and rpm during testing.
4. Evaluate the test data against performance standards.
5. Display and print repair/adjustment recommendations.

- Follow the Smart or Network diagnostic procedures, depending on the equipment features.

USING THE NETWORK DIAGNOSTIC MODE

- Complete the daily Warm-up procedure to display the Set-up screen for operating mode selection.



```
26 APR 1985              SET-UP
01:00 AM PST

                  1. VEHICLE CERTIFICATION
                  2. MANUAL OPERATION
                  3. NETWORK MODE
                  4. SERVICE MODE

        [x]      SELECT PROPER NUMBER AND ENTER


                 50 Records left on tape.
                 Calibrate unit.

                                          [ENTER]
```

- Press **3**, then **ENTER**; to select Network Diagnostic mode from the Set-up screen.

The TAS Screen goes blank and communication is established with the SEA operating modes.

- From the SEA Set-up screen select any mode with the Light Pen.

Use the SEA Programmed Training Course (PTC) for SEA operating instructions.

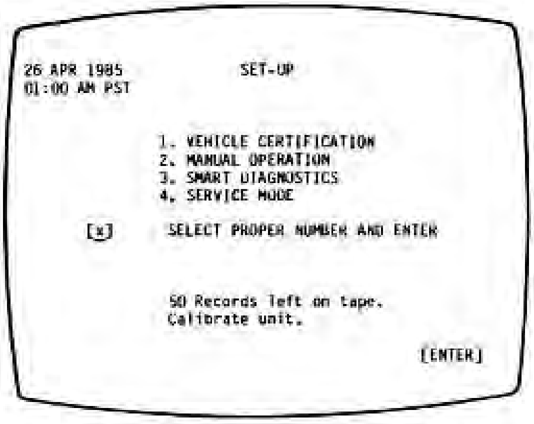
- To return to the TAS Set-up screen, press **ESCAPE** on the TAS keyboard.

This severs communication between the units for independent operation.

USING THE SMART DIAGNOSTIC MODE

To provide quick user friendly instructions, only the primary use prompts are explained in the following step-by-step procedures. Instructions for secondary use and fault/help prompts are explained at the end of this PTC section.

- Complete the daily Warm-up procedure to display the Set-up screen for operating mode selection.



```
26 APR 1985              SET-UP
01:00 AM PST

                  1. VEHICLE CERTIFICATION
                  2. MANUAL OPERATION
                  3. SMART DIAGNOSTICS
                  4. SERVICE MODE

        [x]      SELECT PROPER NUMBER AND ENTER


                 50 Records left on tape.
                 Calibrate unit.

                                          [ENTER]
```

- Press **3**, then **ENTER**; to select Smart Diagnostic mode from the Set-up screen.

Special Function Keys—Activation Status

The **Zero Bench** and **Pump On/Off** keys are deactivated during the vehicle performance test.

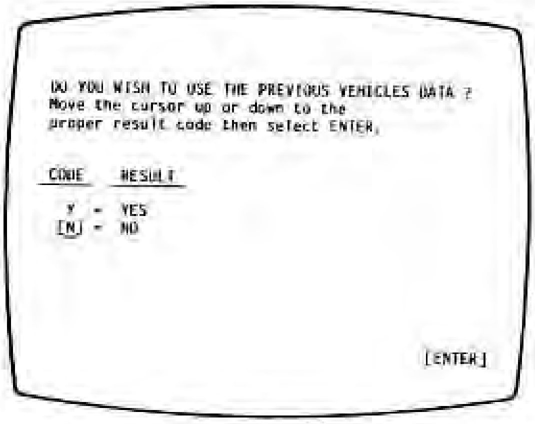
The **Escape** key is activated to stop the test and return to the Set-up screen.

To erase entries, press **Clear** or **Delete**. To review entries, press **Last Entry** or **Next Entry**. Data must be selected, on the current screen, for the review keys to work.

Use the **Cursor** or **Alphanumeric** keys to make a selection on the Data Entry screens.

Smart Diagnostic Test Screens

1. PREVIOUS DATA SCREEN



```
DO YOU WISH TO USE THE PREVIOUS VEHICLES DATA ?
Move the cursor up or down to the
proper result code then select ENTER.

 CODE    RESULT

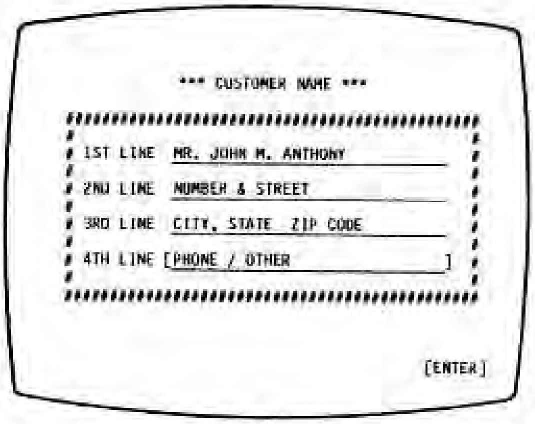
   Y  -  YES
  [N] -  NO

                                       [ENTER]
```

This step precedes the Customer Name screen and eliminates reselecting data for consecutive tests to the same vehicle. The data from the last test is saved and recalled during the next test.

- To receive preselected Data Entry screens; select **Y** (yes), using the **Cursor** keys, then press **ENTER**.
- To manually select all Data Entry screens; select **N** (no), using the **Cursor** keys, then press **ENTER**.

2. CUSTOMER NAME SCREEN



```
                 *** CUSTOMER NAME ***

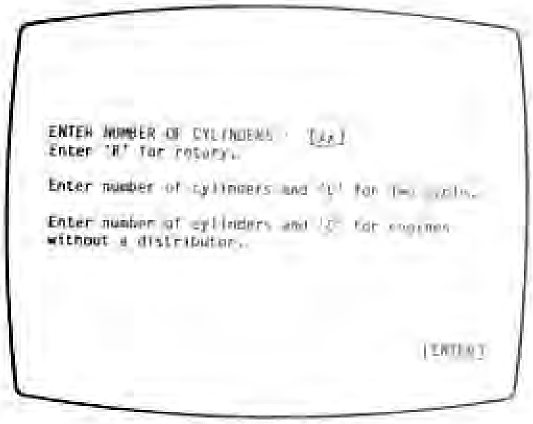
##############################################
#                                            #
# 1ST LINE  MR. JOHN M. ANTHONY              #
#                                            #
# 2ND LINE  NUMBER & STREET                  #
#                                            #
# 3RD LINE  CITY, STATE  ZIP CODE            #
#                                            #
# 4TH LINE [PHONE / OTHER                  ] #
#                                            #
##############################################

                                       [ENTER]
```

This screen information will appear on the printout.

- Type the customer's name into the first line. When correct, press **ENTER**; to advance the to the next line.
- Repeat this procedure with desired data for lines 2, 3, and 4.
- To bypass the Customer Name screen, press **ENTER** for each blank line.

3. NUMBER OF CYLINDERS SCREEN



```
ENTER NUMBER OF CYLINDERS :  [xx]
Enter 'R' for rotary.

Enter number of cylinders and 'C' for two cycle.

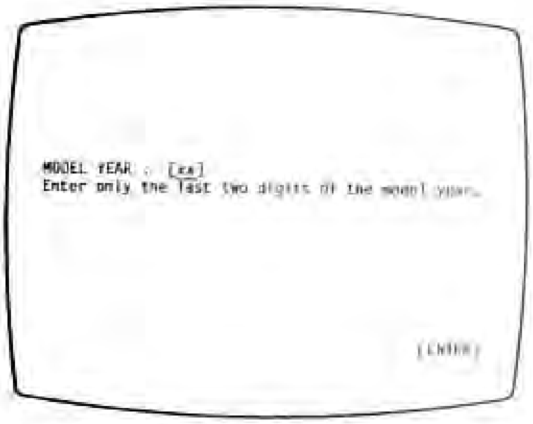
Enter number of cylinders and 'C' for engines
without a distributor.

                                       [ENTER]
```

The Number of Cylinders screen will also tailor the rpm for special engine or ignition classifications.

- Type in the number of engine cylinders or rotors.
- Press **R** for Rotary engine, or **C** for two-cycle and distributorless spark ignition engines, then press **ENTER**.

4. MODEL YEAR SCREEN

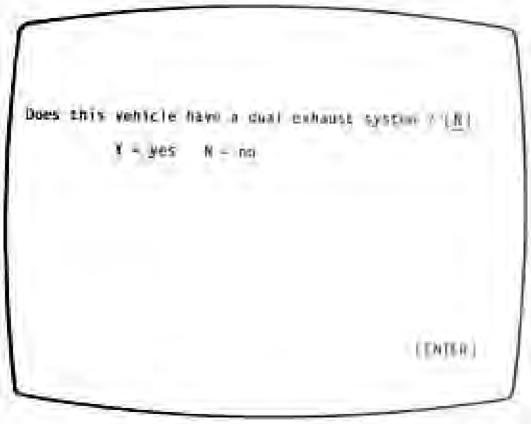


```
MODEL YEAR :  [xx]
Enter only the last two digits of the model year.

                                       [ENTER]
```

- Type in the last two digits of the vehicle model year, then press **ENTER**.

5. DUAL EXHAUST QUERY SCREEN



```
Does this vehicle have a dual exhaust system ? [N]

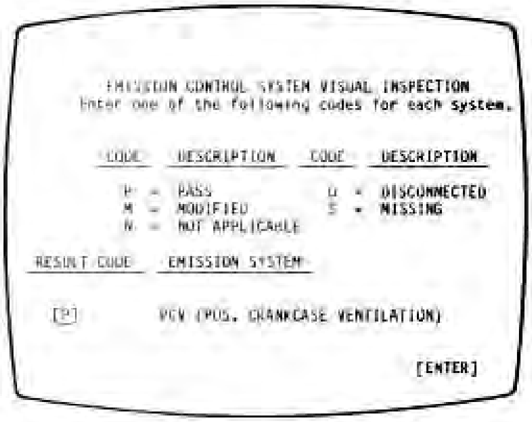
          Y = yes    N = no

                                       [ENTER]
```

- Press **Y** (yes) or **N** (no), then press **ENTER**; to answer the Dual Exhaust query.

Dual exhaust systems have separate pipes from the exhaust manifold back. The presence of dual tailpipes does not always mean the vehicle has dual exhaust.

6. VISUAL INSPECTION SCREEN



```
        EMISSION CONTROL SYSTEM VISUAL INSPECTION
      Enter one of the following codes for each system.

     CODE    DESCRIPTION     CODE    DESCRIPTION

      P  =  PASS               D  =  DISCONNECTED
      M  =  MODIFIED           S  =  MISSING
      N  =  NOT APPLICABLE

 RESULT CODE   EMISSION SYSTEM

   [P]          PCV (POS. CRANKCASE VENTILATION)

                                            [ENTER]
```

Inspect the vehicle's emission control systems and record your findings on the Visual Inspection screen.

- Press the appropriate **Alpha** code for the emission control system displayed, then press **ENTER**.

Alpha Codes:

P = Pass.
M = Modified.
N = Not applicable.
D = Disconnected.
S = Missing.

- Repeat this procedure for each emission control system as it is displayed.

Emission Control Systems:

PCV = Positive Crankcase Ventilation.

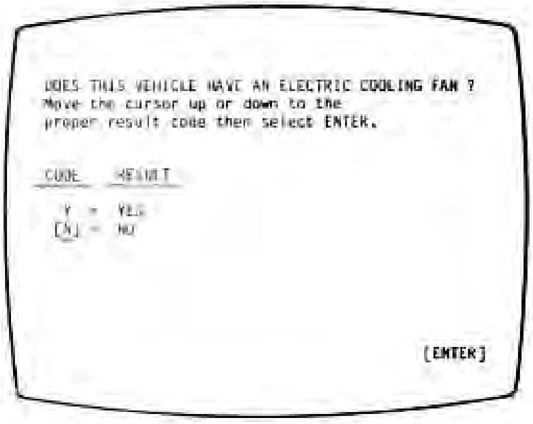
AI = Air Injection / Pulse Air Injection.

OX = Oxidizing Catalyst Converter (oxidation of HC and CO, two-way).

TWC = Three Way Converter (oxidation of HC and CO, reduction of NOx).

EGR = Exhaust Gas Recirculation.

7. ELECTRIC RADIATOR FAN QUERY



```
DOES THIS VEHICLE HAVE AN ELECTRIC COOLING FAN ?
Move the cursor up or down to the
proper result code then select ENTER.

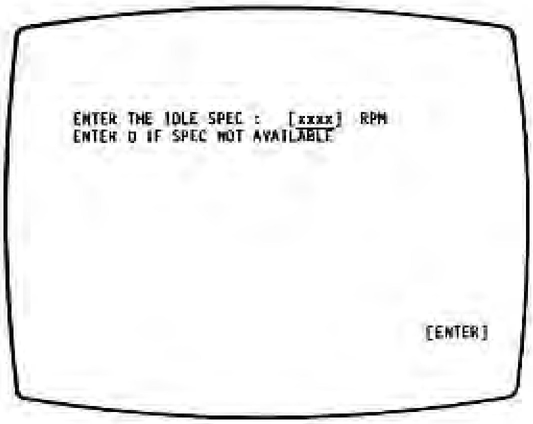
 CODE   RESULT

   Y  =  YES
  [N] =  NO

                                            [ENTER]
```

- Select **Y** (yes) or **N** (no), using the **Cursor** keys, then press **ENTER**; to answer the fan query.

8. IDLE SPEED SPEC SCREEN

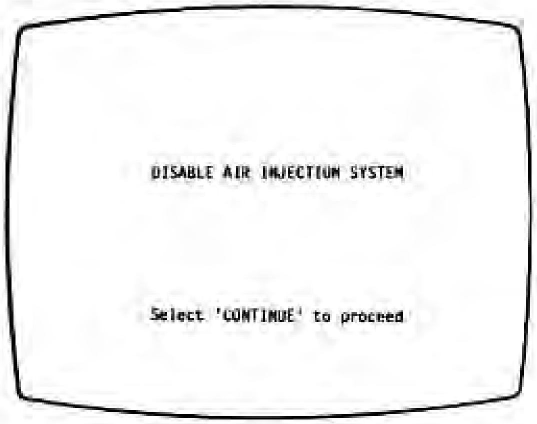


```
ENTER THE IDLE SPEC :   [xxxx]  RPM
ENTER 0 IF SPEC NOT AVAILABLE

                                        [ENTER]
```

- Type in manufacturer's idle speed specification from the underhood sticker, then press **ENTER**.

8.1 DISABLE AIR INJECTION SCREEN



```
          DISABLE AIR INJECTION SYSTEM

          Select 'CONTINUE' to proceed
```

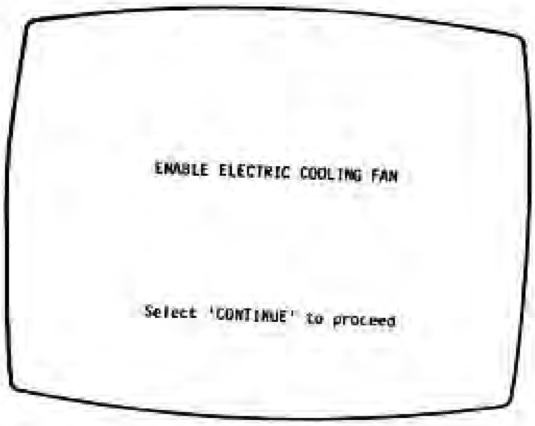
This step appears for vehicles identified as having air injection.

- Disable the air injection system, then press **CONTINUE**.

Disconnect the air circuit between the pump outlet and the engine exhaust. Plug the hose leading to the engine exhaust.

For pulse-air systems, interrupt the air circuit on either side of the pulse-air valve. Plug it so air cannot enter the engine exhaust.

8.2 ENABLE ELECTRIC FAN SCREEN


ENABLE ELECTRIC COOLING FAN

Select 'CONTINUE' to proceed

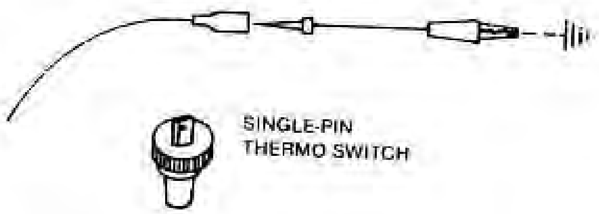
This screen appears for vehicles identified as having an electric cooling fan.

- Enable the electric cooling fan, then press **CONTINUE**.

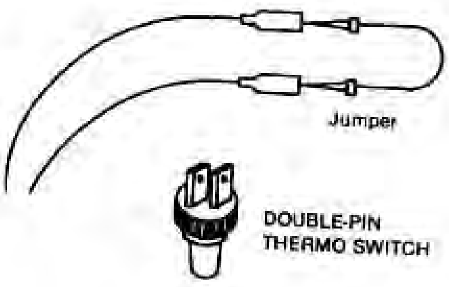
Continuous fan operation prevents intermittent electrical loading of the engine, thus stabilizing the engine rpm for consistent test results.

Fan circuit designs vary. However, they all have a thermo-switch to sense engine temperature. This switch can complete the motor circuit, energize a relay, or signal a computer that controls the fan motor. Generally, the easiest place to enable the fan motor is at the thermo-switch. Separate the harness at the thermo-switch and use one of the following options to allow the fan to energize when the key is turned on.

- Some fans are enabled when the harness is removed from the thermo-switch. Try this method first.
- If the thermo-switch has a single terminal, use a jumper wire to ground the harness.



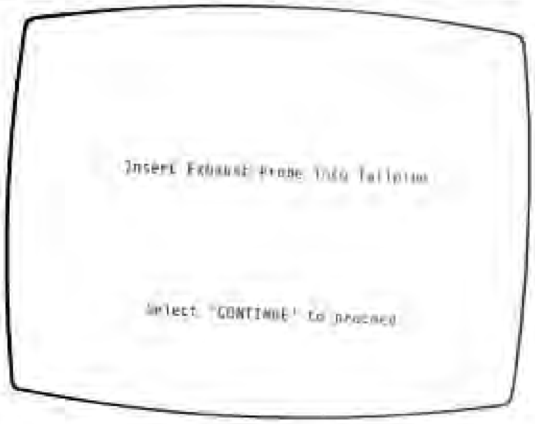
- If the thermo-switch has a double terminal, use a test light to check if both wires in the harness are hot (+). If they are, use a jumper to ground one of the harness wires. If only one is hot, the other is likely to be ground—join the two harness wires with a jumper wire.



When the thermo-switch is hard to access, the operator may want to energized the fan at the motor terminal once the harness is removed.

- For a motor with one terminal, use a jumper wire to apply battery plus (+) to the motor terminal.
- For a motor with two terminals, apply battery plus (+) to one motor terminal to see if the motor will run. If the motor fails to run, apply battery minus (-) to the other terminal.

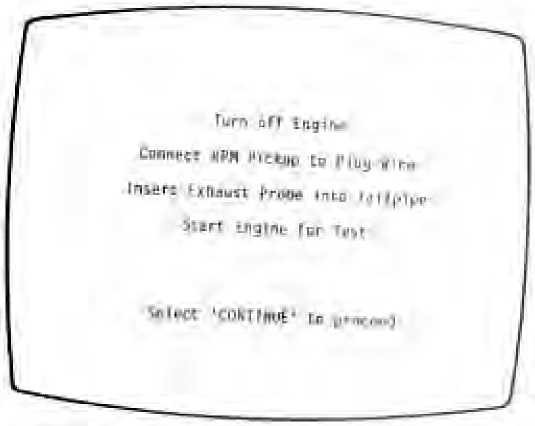
9. INSERT EXHAUST PROBE SCREEN


Insert Exhaust Probe Into Tailpipe

Select 'CONTINUE' to proceed

- Insert the exhaust probe at least 12 inches into the tailpipe, then press **CONTINUE**.

10. PREPARE FOR TEST SCREEN


Turn off Engine

Connect RPM Pickup to Plug-Wire

Insert Exhaust Probe into Tailpipe

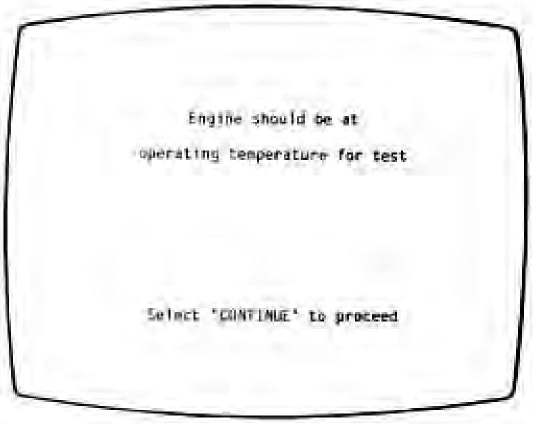
Start Engine for Test

Select 'CONTINUE' to proceed

- Prepare the vehicle for the diagnostic test, then press **CONTINUE**.

1. Turn off the engine.
2. Connect the rpm pickup to any plug wire with the arrow pointing towards the spark plug.
3. Start the engine to warm and stabilize the engine temperature.

11. VERIFY TEMPERATURE SCREEN



```
Engine should be at

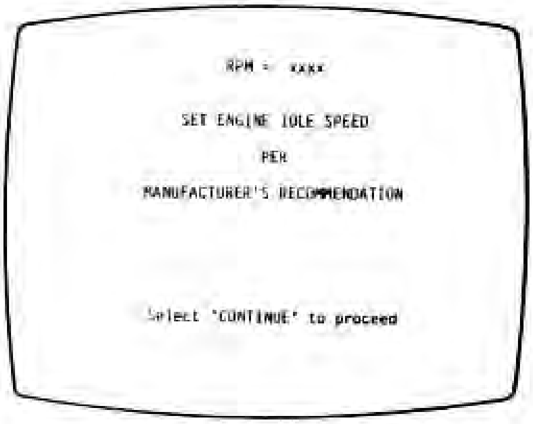
operating temperature for test




Select 'CONTINUE' to proceed
```

- Verify that the engine temperature is normal and stable, then press **CONTINUE**.

12. SET IDLE SPEED & STATUS SCREEN



```
RPM =  xxxx

SET ENGINE IDLE SPEED

PER

MANUFACTURER'S RECOMMENDATION

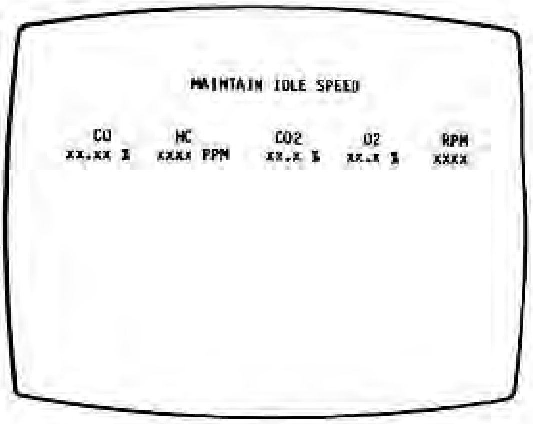


Select 'CONTINUE' to proceed
```

- Prepare the vehicle for an idle speed check by following the procedures on the OEM underhood sticker. This can include: turning on the head lights and air conditioning, setting the parking brake and placing the transmission in drive, etc... Follow appropriate safety precautions to prevent personal injury and property damage.

  It is not necessary to adjust the idle speed at this time if it is within 300-1500 rpm. Merely prepare the vehicle to operate under the same idle conditions listed on the OEM sticker.
- Allow the throttle to be released to its normal idle speed check position, then press **CONTINUE**; to start the analysis.

13. IDLE ANALYSIS SCREEN

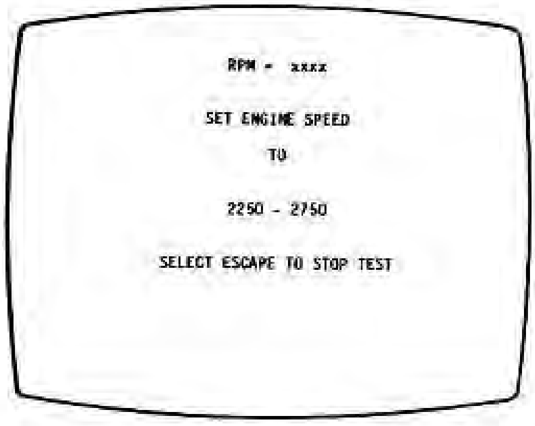


```
              MAINTAIN IDLE SPEED

   CO         HC          CO2       O2       RPM
xx.xx %   xxxx PPM     xx.x %    xx.x %     xxxx
```

This screen displays the gas and rpm values during analysis. The test automatically continues.

14. SET CRUISE SPEED & STATUS SCREEN



```
RPM =  xxxx

SET ENGINE SPEED

TO

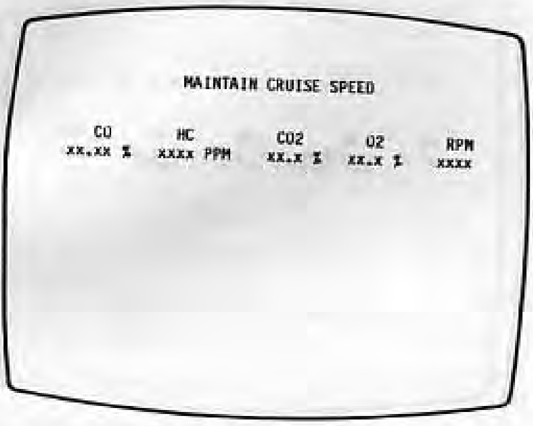
2250 - 2750

SELECT ESCAPE TO STOP TEST
```

Do Not Accelerate With The Vehicle In Gear.

- Prepare the vehicle for the cruise analysis. This can include placing the transmission in park and turning off the accessory load, etc.
- Block the throttle slightly open, to maintain a steady rpm in the range specified on the screen, then press **CONTINUE**; to start the analysis.

15. CRUISE ANALYSIS SCREEN

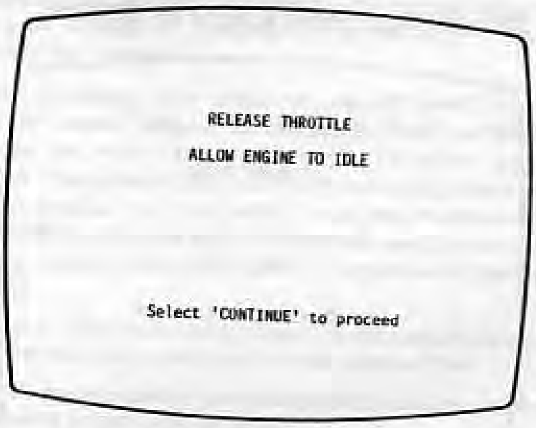


```
            MAINTAIN CRUISE SPEED

   CO        HC          CO2        O2        RPM
xx.xx %  xxxx PPM     xx.x %    xx.x %      xxxx
```

This screen displays the gas and rpm values during analysis. The test automatically continues.

16. RELEASE THROTTLE SCREEN



```
        RELEASE THROTTLE

       ALLOW ENGINE TO IDLE




   Select 'CONTINUE' to proceed
```

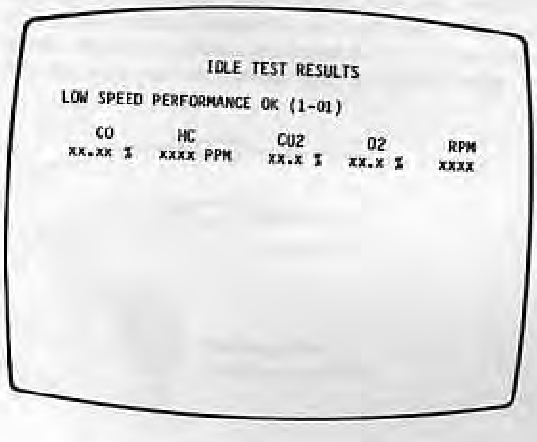
- Release the throttle to allow the engine to idle,then press **CONTINUE**.

Maintain Idle Speed.... is briefly displayed while Idle Analysis repeats.

Test Result Screens

The following result screens appear at the end of each diagnostic test.

17. IDLE TEST RESULT SCREEN

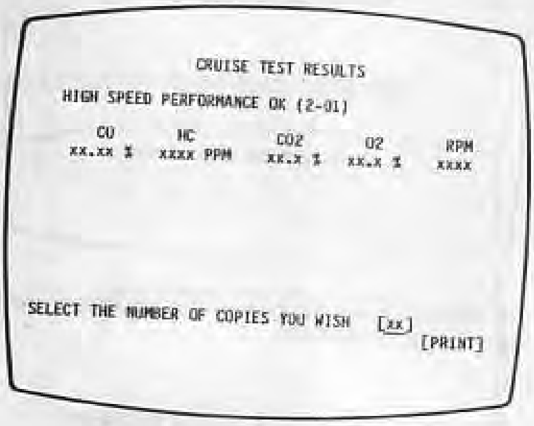


```
               IDLE TEST RESULTS
 LOW SPEED PERFORMANCE OK (1-01)
   CO        HC          CO2        O2        RPM
xx.xx %  xxxx PPM     xx.x %    xx.x %      xxxx
```

The idle result contains repair/adjustment recommendations and values for gas and rpm.

- Press **ENTER** to proceed.

18. CRUISE TEST RESULT SCREEN



```
               CRUISE TEST RESULTS
 HIGH SPEED PERFORMANCE OK (2-01)
   CO        HC          CO2        O2        RPM
xx.xx %  xxxx PPM     xx.x %    xx.x %      xxxx

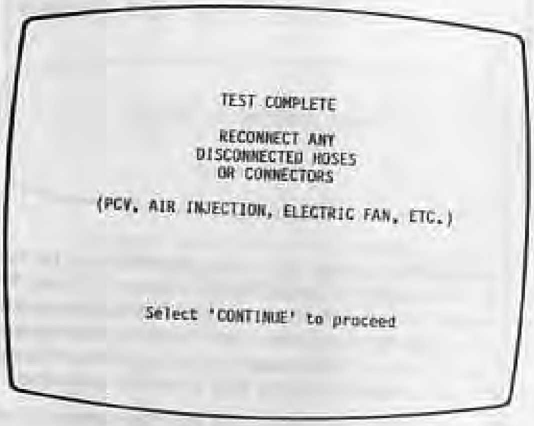



SELECT THE NUMBER OF COPIES YOU WISH   [xx]
                                          [PRINT]
```

The cruise result contains repair/adjustment recommendations and values for gas and rpm.

- Select the number of copies desired, then press **PRINT**.

19. RESTORE CONNECTIONS SCREEN



```
                 TEST COMPLETE

                RECONNECT ANY
              DISCONNECTED HOSES
                OR CONNECTORS

  (PCV, AIR INJECTION, ELECTRIC FAN, ETC.)



         Select 'CONTINUE' to proceed
```

- Appropriately reconnect or disconnect any vehicle hoses or electrical connections that were altered for the test. The Set-up screen is automatically displayed if a copy is selected on the Cruise Result screen.
- If no copy is selected on the Cruise Result screen, press **CONTINUE**; to proceed to the Set-up screen.
- Repair or adjust the vehicle as recommended, then retest to verify.

RESULT REFERENCE NUMBER GLOSSARY

The Smart Diagnostic test result lists any problems sensed during the idle or cruise test. Each item listed is assigned a reference number, and is explained in the following glossary. Perform any adjustment, repair, or verification that is needed.

Idle Reference Numbers

1-01
LOW SPEED PERFORMANCE OK

This test result indicates that the air-fuel mixture and the idle speed adjustment is within acceptable performance limits.

1-02 ADJUST
IDLE SPEED TOO LOW

This test result indicates the engine curb idle speed is too low and may cause stalling or hesitating problems. Some vehicles are set extremely low by the manufacturer, so do not set higher than specified unless customer has stalling problems.

- Adjust the engine rpm using the manufacturer's specifications and procedures.

1-03 ADJUST
IDLE SPEED TOO HIGH

This test result indicates that the engine curb idle is too high and may cause dieseling when shut off, or excessive fuel consumption complaints. Check the throttle linkage for binding and sticking.

1-04 REPAIR/ADJUST
IDLE MIXTURE TOO LEAN

This test result indicates that the air/fuel mixture is excessively lean and may cause engine misfire and excessive idle roughness. This can be caused by a central air leak as well as a carburetor or injector malfunction.

Lean Mixtures

Excessively lean mixtures can cause overheating within the combustion chamber and the potential for detonation is greater. The CO and HC readings along with the plug firing voltage and time can provide clues to lean mixture settings.

A lean mixture is excessive O_2 for the amount of HC and the result is low CO readings. If the AFR is lean enough to cause misfiring, unburned fuel will be exhausted in the form of hydrocarbons (HC).

1-05 REPAIR/ADJUST
IDLE MIXTURE TOO RICH

This test result indicates that the engine air-fuel mixture is too rich as a result of dirty carburetor air bleeds, high float level, misadjusted carburetor mixture screws, injector/injection control malfunctions, etc.

Rich Mixtures

Excessively rich mixtures can cause poor mileage, fouled plugs and increased engine wear.

A rich fuel mixture is usually indicated by a higher CO reading since a rich mixture uses the available oxygen. The HC reading will be slightly higher.

1-06 REPAIR
EXCESSIVE HC/ENGINE MISFIRE

This result indicates that the computer sensed a combustion problem (misfire) by the excessively high HC. Combustion is affected in varying degrees by the condition of the fuel metering, engine mechanical, and spark delivery systems.

A major fault in one of these systems like no spark to a cylinder, no compression, and inadequate air-fuel charge is likely to also cause excessive idle roughness (Ref. 1-07). When reference 1-06 (excessive HC) appears without reference 1-07 (roughness), it is likely to be caused by a moderate combustion problem. If the nature of the problem is AFR related result 104 (mixture lean) or result 105 (mixture too rich) will help verify this.

Check for:

- intermittent plug firing.
- lean misfire caused by lack of fuel or excess air.
- EGR related misfire.
- less common problem of rich misfires caused by very high float bowl fuel level, leaky cold start valve, or fuel pressure regulator.

1-07 REPAIR/ADJUST
EXCESSIVE IDLE ROUGHNESS— MIXTURE PROBLEM

This test result is triggered by rough engine idle. Improper idle air-fuel ratio can cause this symptom. Review any accompanying reference numbers to verify that the roughness is not related to another condition like electrical misfire, etc.

Check for:

- Carburetor circuits/adjustments
- Air leaks
- Fuel delivery components
- Computerized engine systems codes/sensors/ actuators/microprocessor

An EGR problem could trigger this result instead of 1-08 if (during vehicle data entry) the operator neglected to tell the computer that the engine being tested had an EGR valve.

1-08 REPAIR/ADJUST
EXCESSIVE IDLE ROUGHNESS— MIXTURE/EGR PROBLEM

This test result indicates that the engine idle speed is unstable or erratic. This is caused by a combustion problem, in one or a few cylinders, that interferes with smooth power flow.

The effect one bad cylinder has on the idle roughness depends on the number of cylinders the engine has. One dead cylinder out of eight is less noticeable than one out of four. Also, multiple dead cylinders are less noticeable when they are evenly distributed in the engine firing order.

Normally this result is related to major faults like no spark to a cylinder, no compression, or severe air-fuel charge problems. Reference 1-08 generally appears with other reference numbers that provide clues to help isolate the problem.

Check for:

- a non-firing spark plug
- valve train trouble burned valve, sticky valve, worn cam lobe
- a rich misfiring cylinder caused by a leaky injector
- lean misfires caused by lack of fuel or excess air
- EGR related misfire.

The density of the air-fuel charge inducted into the combustion chamber is affected by faulty EGR systems and valve train problems.

An EGR system that meters exhaust gas at the wrong time or in excessive amounts initially causes less air and fuel to be drawn into the cylinder during the intake stroke. The air-fuel mixture at this time may be at the proper ratio to support combustion but, some of the combustion chamber space normally occupied by these "burnables" will be taken by inert exhaust gas. This hampers ignition of the air-fuel mixture and causes a barrier to flame travel. Misfire results, and unused air (O_2) and fuel (HC) show an increase in the exhaust while CO may remain basically normal. A rich AFR and good combustion is required to increase CO.

Once EGR related misfiring begins some of the unused air (O_2) and fuel (HC) will reenter the engine cylinder with the recirculating exhaust gas. This O_2 will compound the misfire problem by causing a leaner AFR and may mislead the operator into looking just for a lean misfire problem. A clue to the real problem may be gained through artificial enrichment with propane. Enrichment of a lean misfire causes the HC and CO to return to normal levels. However, with an EGR related misfire, the additional density problem cannot be compensated for and the HC and CO levels will not completely return to normal.

1-09 REPAIR
MIXTURE VARIATIONS

This result indicates that the CO was unstable and constantly drifting. It also indicates a higher than normal CO reading. This can be caused by a number of items such as:

- Leaky needle and seat
- Sticking float
- Leaking fuel injector

1-10
PCV WAS NOT DISCONNECTED— RICH MIXTURE OR CONTAMINATED CRANKCASE INDICATED

This result indicates that the computer saw high CO and asked the operator to disconnect the PCV Valve. However, the operator chose to bypass this direction and didn't remove the PCV Valve. Therefore, the possibility of a fuel contaminated crankcase is indicated. The test should be repeated. Make every attempt to disconnect the PCV System plumbing if the PCV Valve cannot be removed.

If the PCV system cannot be disabled, or as an alternate to disconnecting the PCV, the operator may decide to change the oil and then repeat the test to see if CO has reduced. If the CO is still high on the retest, after the oil change, the indicated problem is rich fuel mixture. See Reference 1-05.

1-11 REPAIR/CHANGE OIL
FUEL IN CRANKCASE—RICH CARB OR FUEL INJECTION/FUEL PUMP/MISFIRE/PCV

The test result indicates that the excessive CO drop was detected with the PCV valve removed. This is caused by fuel in the crankcase.

Check for:

- Cylinder blowby.
- Low flow in the PCV system.
- Short trip driving (engine doesn't reach a desireable temperature).
- Leaky block mounted fuel pump (can drip gasoline directly in the crankcase).
- Leaky fuel inlet needle and seal
- Choke doesn't open properly
- Leaking fuel injector
- Leaking cold start valve
- Excessive fuel pressure. Check fuel pressure from pump/pressure regulator.
- A cylinder misfiring for a long time.

Once the problem is eliminated, the engine oil should be changed and the PCV System checked.

Do not attempt to adjust the idle mixture in an engine that has fuel in the crankcase.

1-12 REPAIR
AIR LEAK OR UNEVEN FUEL DISTRIBUTION

This test result indicates that the CO reading was high, however the engine speed up during enrichment was also excessive. This leads us to two possible problems.

First, the excessive speed up during enrichment could be caused by an air leak to a cylinder. The high CO readings are caused by the balance of the cylinders running rich because the carburetor was adjusted excessively rich to overcome the lean condition.

Secondly, on "V" engines the improper balance of the idle mixture screws—one too lean and the other too rich.

1-13
EXCESSIVE CO EMISSIONS

See reference 1-14

1-14
EXCESSIVE HC EMISSIONS

These results indicate the exhaust emissions exceed the state specification, however, the nature of the problem does not affect rpm and exhaust emissions enough to trigger a poor engine performance result. The environmental consequence of excessive emissions dictates that additional maintenance or adjustment is needed. We recommend a complete all system test with a computer/scope analyzer.

Cruise Reference Numbers

2-01
HIGH SPEED PERFORMANCE OK

This test result indicates that the air/fuel ratio at cruising speed appears to be within acceptable performance limits.

2-02
NOT AVAILABLE

2-03 REPAIR
RICH MIXTURE AT HIGH SPEED

This result indicates that the analyzer saw high CO at cruise speed. Normally a reduction in CO and HC with an increase in CO_2 should occur. This can be attributed to increased combustion efficiency at cruise.

One or a combination of the following problems can cause rich mixture at high speed.

- Fuel pressure too high. Check fuel pump/pressure regulator.
- Leaking injector/cold start valve.

- Cold enrichment devices operating at the wrong time.
- Injector duration too long.
- Faulty Closed-loop sensors or controls e.g., coolant switch in cold enrich position, O_2 sensor sending a lean mixture message.
- Carburetor needs service.

2-04 REPAIR
EXCESSIVE HC/ENGINE MISFIRE

This result indicates that the analyzer saw a significant increase in HC emissions and a reduction in CO_2. Poor burning within the combustion chamber can be caused by the following:

- Excessively rich or lean AFR.

To check for a lean misfire, artificially enrich the mixture at cruise speed and see if the engine smooths out. HC reading should decrease, CO and CO_2 increase. If it does, check those items which cause lean misfire condition at cruise speed. Generally small intake manifold vacuum leaks show up more at idle speed. Look for larger air leaks and fuel delivery problems.

To check for a rich misfire, install a small brass tapered needle type valve in parallel to a large vacuum hose like the PCV valve hose. Run the engine at cruise and open the valve a little at a time. Observe the gases. If the HC and CO drops and the CO_2 increases, a rich condition is likely. Check those components that may cause excessive richness/misfire.

- Ignition system misfire

Check ignition voltage, firing time, and timing with a computer/scope analyzer.

- EGR system or valve train problems.

See Manual Mode Section.

2-05
EXCESSIVE CO EMISSIONS

See Reference 2-06

2-06
EXCESSIVE HC EMISSIONS

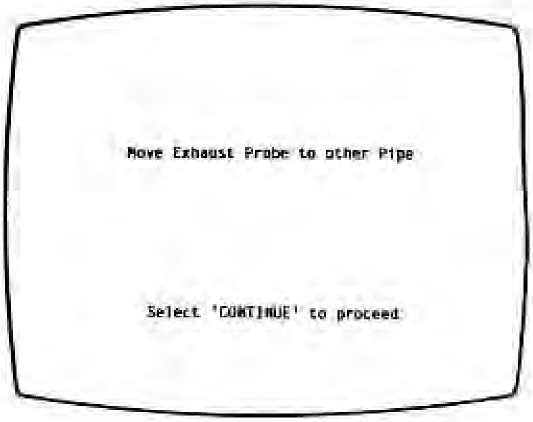
These results indicate the exhaust emissions exceed the state specification, however, the nature of the problem does not affect rpm and exhaust emissions enough to trigger a poor engine performance result. The environmental consequence of excessive emissions dictates that additional maintenance or adjustment is needed. We recommend a complete all system test with a computer/scope analyzer.

OTHER DIAGNOSTIC TEST SCREENS

The following screens can appear depending on the vehicle features entered and gas and rpm values sensed during analysis.

- Complete the appropriate screens.

MOVE EXHAUST PROBE SCREEN



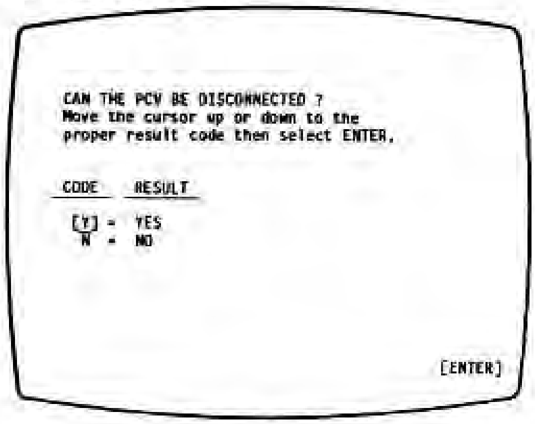
Move Exhaust Probe to other Pipe

Select 'CONTINUE' to proceed

This screen appears for vehicles identified as dual exhaust equipped.

- Move the probe to the other pipe, then press **CONTINUE**; to repeat the idle and cruise analysis.

PCV QUERY SCREEN



CAN THE PCV BE DISCONNECTED ?
Move the cursor up or down to the
proper result code then select ENTER.

CODE RESULT

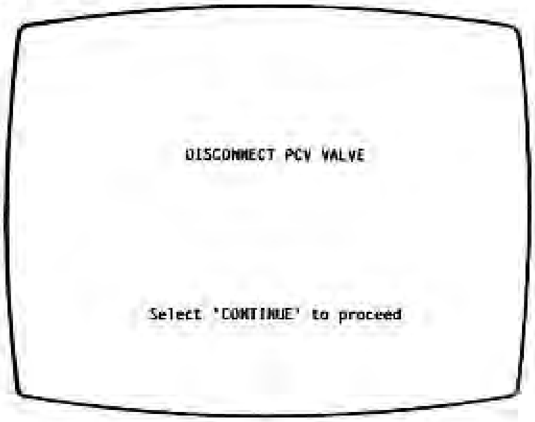
[Y] = YES
N = NO

[ENTER]

- Select **Y** (yes) or **N** (no), using the **Cursor** keys, then press **ENTER**; to indicate if the PCV valve can be disconnected.

Maintain Idle Speed.... is briefly displayed while Idle Analysis repeats.

DISCONNECT PCV VALVE SCREEN



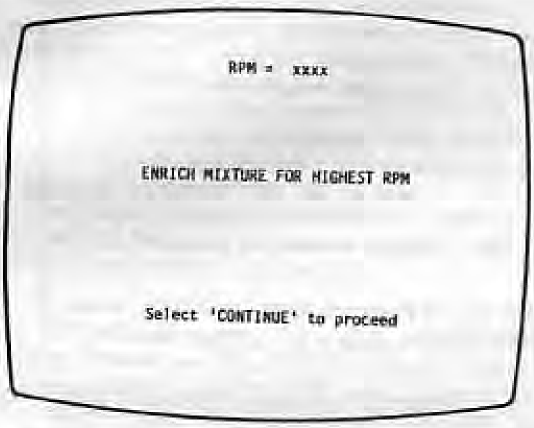
DISCONNECT PCV VALVE

Select 'CONTINUE' to proceed

- Disconnect the PCV valve and allow the valve to meter fresh air; press **CONTINUE**.

Maintain Idle Speed is briefly displayed while Idle Analysis repeats.

ENRICH THE MIXTURE SCREEN



```
RPM =  xxxx

ENRICH MIXTURE FOR HIGHEST RPM

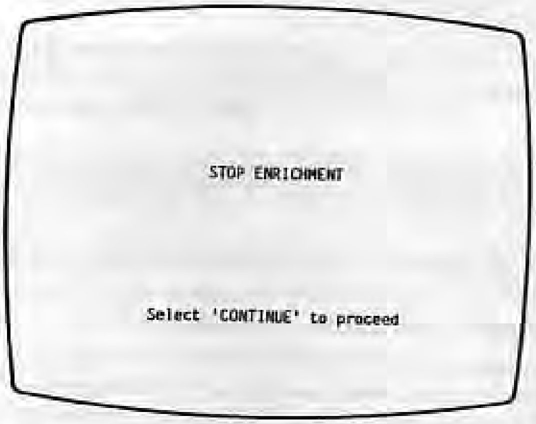
Select 'CONTINUE' to proceed
```

- Artificially enrich the mixture for highest rpm, then press **CONTINUE**.

Meter propane into the air horn so it is evenly distributed to all the intake manifold runners. Without moving the throttle, increase enrichment slowly so rpm change is easily observed. If the propane flow is increased too fast the peak rpm will be missed because the engine becomes instantly rich—false test conclusions will result. With a little practice, an operator can become very good at sensing exactly what mixture the engine needs for the highest rpm.

Maintain Idle Speed.... is briefly displayed while Idle Analysis repeats.

STOP ENRICHMENT SCREEN



```
STOP ENRICHMENT

Select 'CONTINUE' to proceed
```

- Turn off the propane enrichment; press **CONTINUE**.

FAULT/HELP PROMPTS

The following Fault prompts can be displayed depending on gas and rpm values sensed during the Smart Diagnostic test and responses to the Data Entry screens.

NUMBER OF ENGINE CYLINDERS NOT VALID, TRY AGAIN: Appears if over 16 cylinders are entered. Enter the proper number of cylinders, or exit the test.

VEHICLES OLDER THAN 1955 SHOULD NOT BE RUN ON THIS ANALYZER....: The analyzer will not test vehicles older than 1955. Enter the proper year, or exit the test.

ENTER ONE TYPE OF CATALYST: Appears if the vehicle is entered as having both types of converters. Enter a **N** (not applicable) for one type.

NO RPM SIGNAL : Indicates no tach signal is sensed. Correct the fault and the test automatically proceeds. If not, further progress is rejected.

1. Verify that the engine is running.
2. Try connecting to another plug wire.
3. Check the rpm pickup for proper connection to the TAS unit and engine.

- If repair is necessary, press **ESCAPE** to exit the test.

ERRATIC RPM SIGNAL : Indicates the engine rpm is rough or the pickup is receiving electrical noise.

- Repair the fault and press **CONTINUE**.

1. Check for faulty ignition parts.
2. Try moving the pickup to another plug.

- If necessary, press **ESCAPE** to exit the test.

CO_2 DILUTION ERROR : Indicates a low CO_2 value is sensed during exhaust analysis. Exhaust sample dilution is indicated. Accurate testing is not possible with a diluted sample. Correct the fault and the test automatically proceeds. If not—further progress is rejected. See PTC section 4—TAS Service mode, Manual Operation—item 6; to check for air leaks.

1. Check exhaust probe insertion depth.
2. Check for air leaks into the vehicle exhaust system, TAS probe, hose, or filter system.

- If necessary, press **ESCAPE** to stop the test.

SET ENGINE SPEED TO 300-1500....: Appears if the idle speed drifts too high or low during exhaust analysis.

- Set the idle speed within the range specified on the screen, then press **CONTINUE**; to restart the analysis.
- If necessary, press **ESCAPE** to stop the test and return to the Set-up screen.

SET ENGINE SPEED TO 2250 2750....: Appears if the cruise speed drifts too high or low during exhaust analysis

- Set the cruise speed within the range specified on the screen, then press **CONTINUE**; to restart the analysis.
- If necessary, press **ESCAPE** to stop the test and return to the Set-up screen.

SECTION 4
ANALYZER SERVICE MODE

This section contains step-by-step service procedures. The service procedures are designed to fulfill the following functions:

1. To install and prepare the analyzer for operation.
2. To enter required data about your place of business into TAS memory.
3. To program your business address or other desired data to appear on the printout.
4. To perform required periodic services. This ensures compliance with analyzer accuracy and test documentation requirements of your state's vehicle testing program.
5. To update TAS operation.
6. To identify and correct faults that occasionally occur.

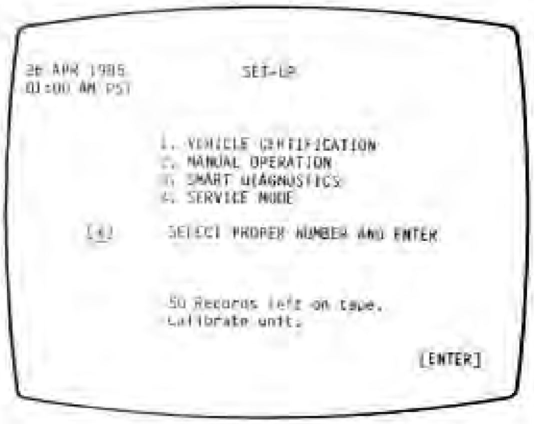
The procedures are easy to perform. Just follow the screen prompts carefully and execute each task as directed. Trying to second guess or anticipate procedural task may cause a "lockout" condition. This could require a service call if the lockout cannot be cleared by the operator. Please follow directions!

USING THE ANALYZER SERVICE MODE

To provide quick user friendly instructions, only primary use prompts are explained within each service procedure. Instructions for secondary use and fault/help prompts are explained at the end of this PTC section.

- Complete the daily Warm-up procedure to display the Set-up screen for operating mode selection.

1. SET-UP SCREEN



```
26 APR 1985             SET-UP
01:00 AM PST

                 1. VEHICLE CERTIFICATION
                 2. MANUAL OPERATION
                 3. SMART DIAGNOSTICS
                 4. SERVICE MODE

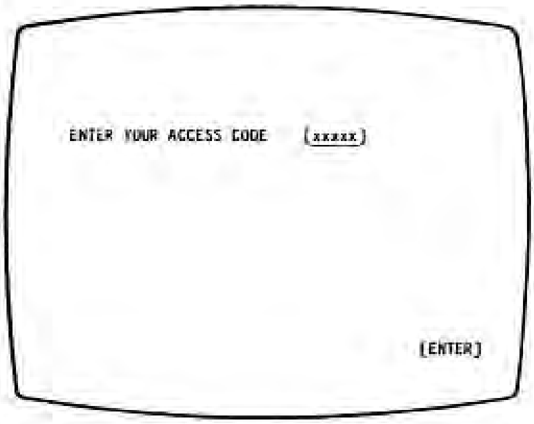
      [4]         SELECT PROPER NUMBER AND ENTER


                 50 Records left on tape.
                 Calibrate unit.

                                        [ENTER]
```

- Press 4, then **ENTER**, to select the TAS Service mode from the Set-up screen.

2. ACCESS CODE SCREEN

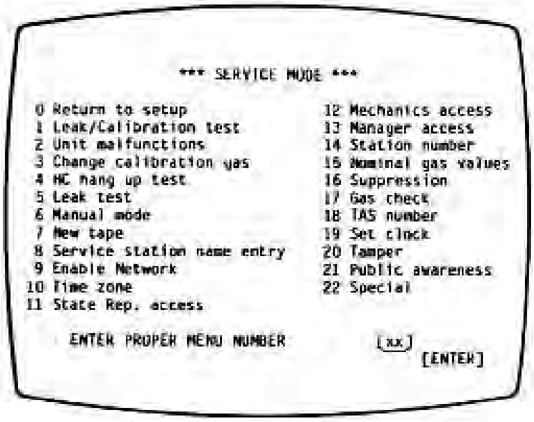


```
ENTER YOUR ACCESS CODE    [xxxxx]

                                        [ENTER]
```

- Type in your access code, then press **ENTER**; to display the Service mode menu.

3. SERVICE MODE MENU



```
                   *** SERVICE MODE ***

 0 Return to setup                     12 Mechanics access
 1 Leak/Calibration test               13 Manager access
 2 Unit malfunctions                   14 Station number
 3 Change calibration gas              15 Nominal gas values
 4 HC hang up test                     16 Suppression
 5 Leak test                           17 Gas check
 6 Manual mode                         18 TAS number
 7 New tape                            19 Set clock
 8 Service station name entry          20 Tamper
 9 Enable Network                      21 Public awareness
10 Time zone                           22 Special
11 State Rep. access

    ENTER PROPER MENU NUMBER                [xx]
                                                [ENTER]
```

The number of items listed on the Service mode menu is controlled by the operators access code / job title.

Mechanics get items 0-6.
Station Managers get items 0-10.
State representatives, items 0, and 11-17.
Allen representatives, items 0-22.

- Select the desired menu item, then press **ENTER**.
- Go to the Service procedure for the menu item selected.

SERVICE MENU PROCEDURES

The service procedures are listed numerically on the following pages.

Leak Calibration Test—item 1

DESCRIPTION

This routine includes a gas calibration, leak test, zeroing the benches, and printing the results.

Calibration adjust the readings of infrared benches to correspond to the values of a known gas blend (calibration gas) being fed into the benches.

Leak Test forms and holds a vacuum on the exhaust sample system to verify its integrity.

Bench Zeroing adjusts the benches to read zero while sampling room air.

Printing provides test documentation.

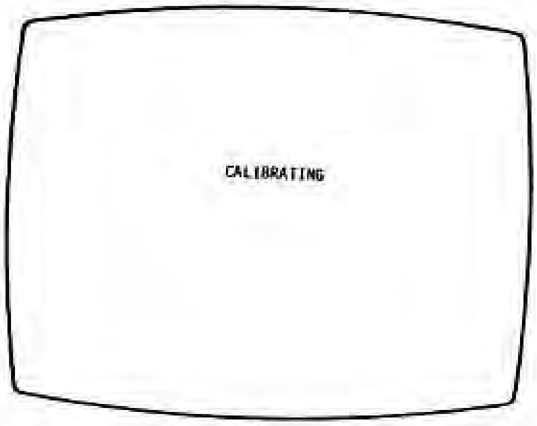
APPLICATION

This routine is required to ensure an accurate Vehicle Inspection test. Also, it will clear some malfunctions/lockouts and prevent service calls. When the Set-up screen says Calibrate Unit or Calibrate Unit To Disable Lockout a Leak Calibration Test is required.

The Leak Calibration Test is also part of the Change Calibration Gas routine.

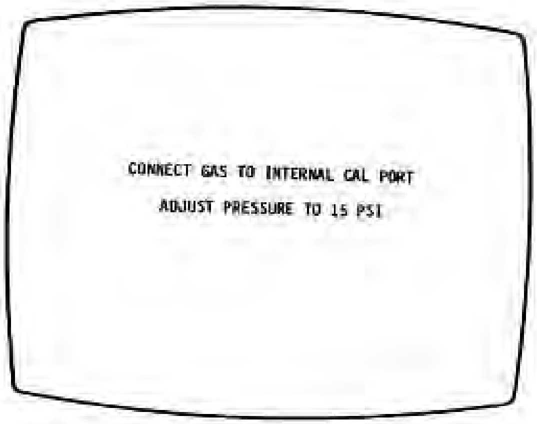
PROCEDURE

- Press 1, then **ENTER**; to select the Leak Calibration Test from the Service mode menu.



CALIBRATING

Calibrating is briefly displayed. The test automatically proceeds.



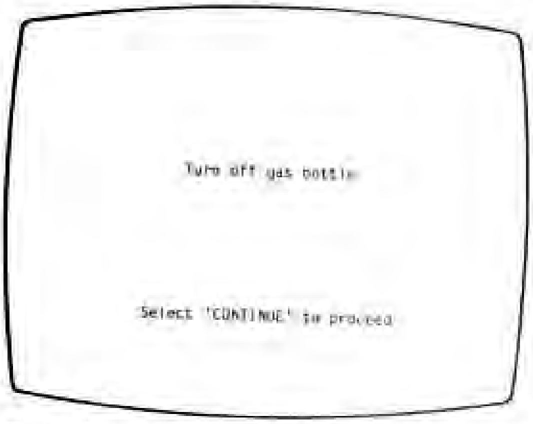
CONNECT GAS TO INTERNAL CAL PORT
ADJUST PRESSURE TO 15 PSI

- Attach the gas bottle hose to the Cal Gas Port on the back of the TAS unit.
- Turn on the gas bottle valve.
- If necessary, adjust the pressure regulator to maintain 15 psi.

When proper pressure is sensed, Calibrating returns briefly. The test automatically proceeds.

If the gas pressure drops, the message Connect Gas To...Adjust Pressure To.... returns until the proper pressure is sensed.

If there is not enough pressure in the gas bottle, press **ESCAPE**, then perform the Change Calibration Gas procedure (item 3).

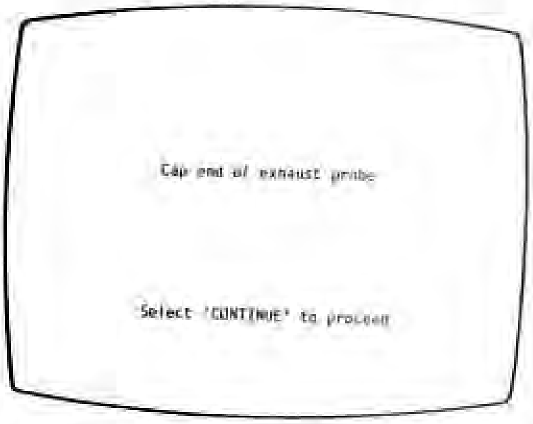


Turn off gas bottle

Select 'CONTINUE' to proceed

- Turn off the gas bottle valve, then press **CONTINUE**.

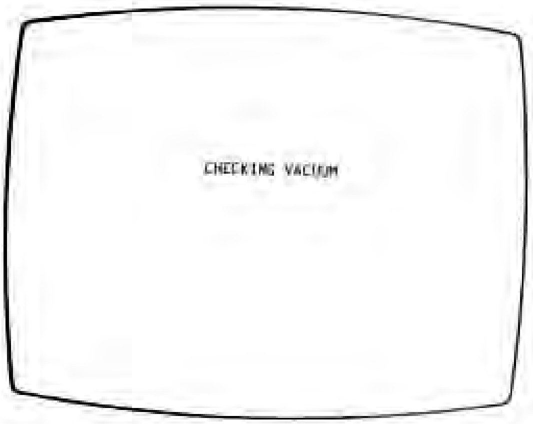
Calibration is complete and the Leak Test begins.



Cap end of exhaust probe

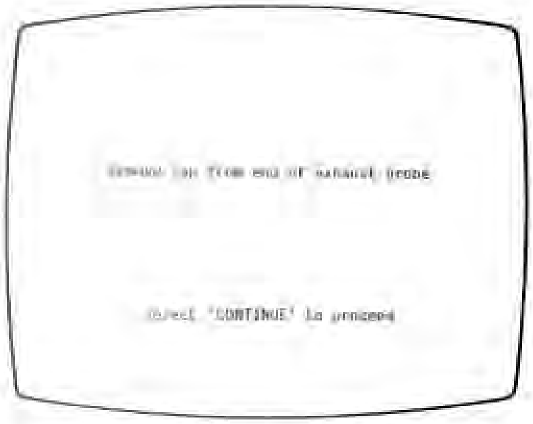
Select 'CONTINUE' to proceed

- Cap the end of the exhaust probe for the leak test, then press **CONTINUE**.



CHECKING VACUUM

Checking Vacuum is briefly displayed. The routine automatically proceeds.



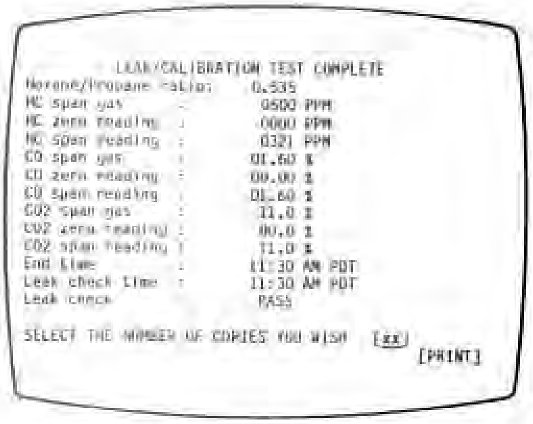
```
Remove cap from end of exhaust probe

Select 'CONTINUE' to proceed
```

- Take the cap off the end of the exhaust probe, then press **CONTINUE**.

The Leak Test is complete and Zeroing the Bench begins.

Zeroing Bench appears (60 sec.) while the bench zero setting is adjusted and the sample system flow is checked. Then, the test result is displayed.



```
        LEAK/CALIBRATION TEST COMPLETE
Hexane/Propane ratio:     0.535
HC span gas        :       0500 PPM
HC zero reading    :       0000 PPM
HC span reading    :       0321 PPM
CO span gas        :      01.60 %
CO zero reading    :      00.00 %
CO span reading    :      01.60 %
CO2 span gas       :       11.0 %
CO2 zero reading   :       00.0 %
CO2 span reading   :       11.0 %
End time           :      11:30 AM PDT
Leak check time    :      11:30 AM PDT
Leak check                 PASS

SELECT THE NUMBER OF COPIES YOU WISH  [xx]
                                         [PRINT]
```

- Type in the number of printouts desired, then press **PRINT**; to print the result and return to the Service mode menu screen.

TEST RESULTS

Hexane to propane ratio: should be identical to the number on the pef tag found on the back of the TAS.

Span gas values: for HC, CO and CO_2 must match the current bottle values entered during the last bottle change.

Zero readings: for HC, CO, and CO_2 are the zero settings for the bench.

Span readings: for HC, CO and CO_2 are the span settings for the bench. CO and CO_2 should be identical to the current bottle values.

The correct HC reading (hexane) is calculated by multiplying the current bottle's propane value by the propane equivalency factor (pef).

The pef number is slightly different for each analyzer. It is located on a round tag attached to the analyzer rear panel, and on a sticker on the bench assembly.

Example:

600 ppm propane
x .535 pef
321 ppm hexane

For this example, the HC reading is 321 ppm plus or minus the percent deviation allowed by the state.

Leak check: indicates the result of the leak test. If the leak test fails (FAIL) the Set-up screen will display a lockout.

Repair the leak (see Manual Operation—item 6, Operators Leak Test), then perform a Leak Test— item 5 to clear the lockout.

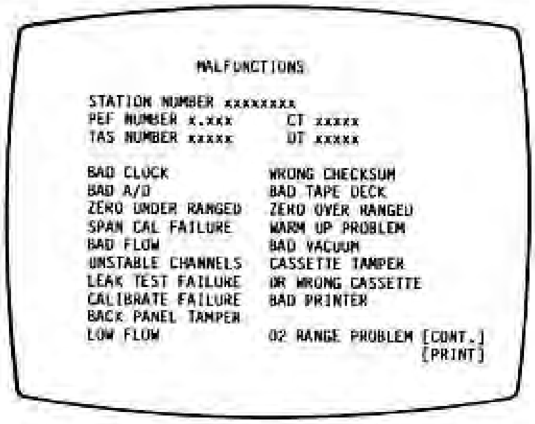
Unit Malfunctions—item 2

APPLICATION

The malfunction message is used to identify and correct most faults that occur.

PROCEDURE

- Press **2**, then **ENTER**; to select the Malfunctions screen from the Service mode menu.



```
              MALFUNCTIONS

STATION NUMBER xxxxxxxx
PEF NUMBER x.xxx       CT xxxxx
TAS NUMBER xxxxx       DT xxxxx

BAD CLOCK             WRONG CHECKSUM
BAD A/D               BAD TAPE DECK
ZERO UNDER RANGED     ZERO OVER RANGED
SPAN CAL FAILURE      WARM UP PROBLEM
BAD FLOW              BAD VACUUM
UNSTABLE CHANNELS     CASSETTE TAMPER
LEAK TEST FAILURE     OR WRONG CASSETTE
CALIBRATE FAILURE     BAD PRINTER
BACK PANEL TAMPER
LOW FLOW              02 RANGE PROBLEM [CONT.]
                                       [PRINT]
```

This screen shows the possible malfunction messages. However, only existing malfunctions are displayed.

- To receive a malfunction printout and return to the Service mode menu; press **PRINT**.
- To return to the Service mode menu without printing; press **CONTINUE**.
- See Malfunction Glossary to clear the malfunction.

MALFUNCTION GLOSSARY

The following list explains each malfunction and recommends procedures to clear them. If the malfunction cannot be cleared, or continues to occur, call a TAS service technician.

Bad Clock: This malfunction is monitored during the Warm-up sequence. It indicates a problem with the TAS clock that times the calibration cycle Turn the unit off (three minutes), then on; to restart the Warm-up cycle. When the Set-up screen is displayed, the date/time must be right.

Bad A/D: Indicates a problem with the gas sampling system. Turn the unit off, then on; to restart a Warm-up cycle. If the problem persist (20 min.), try recalibrating the unit.

Zero Under or Over Ranged: Indicates that the TAS can no longer adjust the zero settings of the gas sampling system. Try pressing the **Zero Bench** key to cure this problem.

Span Cal Failure: Indicates that the span adjustment has drifted out of calibration. Recalibrate the unit to remove the malfunction.

Bad Flow: Monitored during Warm-up before zeroing the bench. Causes a "lockout". Can appear with Unstable Channel malfunction. Indicates a restriction between the Fresh Air port (next to Cal port) and the exhaust sample (dry) pump inlet, or pump trouble. Repair the fault and repeat Warm-up to clear the malfunction.

Unstable Channels: Indicates the gas readings were not stable during the Warm-up cycle. The Warm-up cycle requires fresh uncontaminated air to circulate through the bench and TAS cabinet. Be sure that the Fresh Air Port is unrestricted and the room atmosphere is clear of smoke or other contaminates. Also check the Air Intake Filter for the cooling system. Then restart the Warm-up cycle.

Leak Test Failure: Indicates the sample system cannot form and hold a vacuum, or that the **Escape** key was pressed during a Leak/Calibration test. Check the sample system components for air leaks (see PTC section 4—TAS Service mode, Manual Operation— item 6, Operator's Leak Test). Then execute a Leak Test (see PTC section 4—TAS Service mode, Leak Test—item 5) to clear the malfunction message.

Calibrate Failure: Indicates that the Leak/Calibration test was not completed properly. Reexecute this test, following all instructions, carefully.

Back Panel Tamper: Indicates that the unit has been tampered with. Do not try to remove the back panel. Call your TAS service technician to return your unit to normal operation.

Low Flow: Monitored near the end of the zero bench routine. Will not cause a "lockout". Indicates a restriction between the exhaust probe and the exhaust pump (dry pump) inlet, or pump trouble. Repair the fault and press **ZERO BENCH** to clear the malfunction. Check probe, hose, and both sample filters for restrictions.

Wrong Checksum: Indicates the wrong program tape is in the unit and it does not match the one in TAS memory. Verify that the tape is correct. If it is, restart the Warm-up cycle. If the problem persist, or the tape is wrong install a backup program.

Bad Tape Deck: Indicates a nonrecoverable error in the tape handling system. Try cleaning the tape head and changing the data tape.

Warm-up Problem: Indicates the unit's temperature or gas readings are unstable, or the **Escape** key was pressed during the Warm-up cycle. Wait until you are sure the unit is at its normal operating temperature. Then restart the Warm-up cycle.

Bad Vacuum: Monitored during a Leak Test. Causes a "lockout". Can appear with Leak Test Failure malfunction. Indicates an air leak in the exhaust sample or water separator circuits. Repair the fault and repeat the Leak Test to clear the malfunction. Check the probe cap, probe, hose, both filter bowls, and plumbing for leaks. See Gas Check—item 5, for the Operators Leak Test.

Cassette Tamper or Wrong Cassette: This malfunction indicates that the cassette tamper door was opened (e.g. for head cleaning) and wrong tape was reinstalled. Install the proper tape. Return to the Set-up screen to activate another tape test and clear the "Wrong Tape" malfunction.

Bad Printer: Indicates a problem in the printer or printer circuit. Can cause a lockout of the Certification Test mode if a vehicle inspection report is required by the state. Call a TAS service technician for repairs.

O_2 Range Problem: Indicates an insufficient response from the oxygen cell. Try zeroing the bench or a gas calibration.

OPERATING SYMPTOMS GLOSSARY

Some faults are corrected by using the Operating Symptoms Glossary.

No Monitor or Unit Dead or Unit Won't Load Tape

The Monitor screen turns off after 45 minutes of stand-by. Press any key to turn the screen on.

1. Are the pilot lights on? No - check plug and/or breaker for wall outlet.
2. Are any of the indicator lights blinking? Yes Power down, pause 30 seconds and power back up if same result, unit needs service.
3. If no characters on monitor, lower front bezel and turn brightness control (upper left hand corner). If characters still don't appear on screen, unit requires service.
4. If a character, other than the numbers 0001-0047 appears after message Cassette In Operation call for service.

Keyboard Locks-up Unit Beeps Constantly

1. Turn off the power, pause 30 seconds than turn it on and try again,
2. Disconnect and reconnect keyboard connector located below cassette door.

Monitor has Random Characters or "Garbage" on Screen

1. Power unit down, wait 30 seconds, turn unit back on.

Unit Hangs-up or Locks-up in Middle of Test

This problem is usually caused by the operator depressing keys in the middle of a test or at any time other than when the unit has asked for a key.

1. Remove keyboard connector from back panel (large connector located below cassette door) and reconnect to unit.
2. If problem persists, power unit down and then power back up.

HC Hang-up Problem

1. Inspect filters and replace as necessary.
2. Clean inside of filter bowl with hot soapy water.
3. Return to Set-up screen and press Zero Bench key.

Change Calibration Gas—item 3

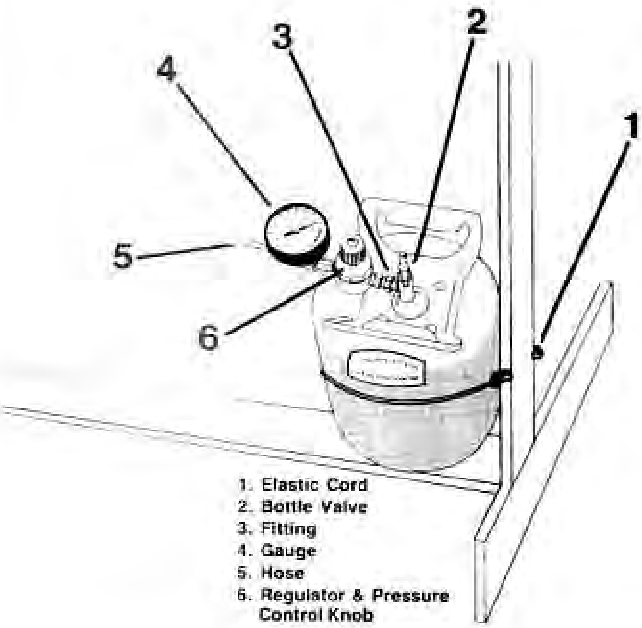
DESCRIPTION

Changing the calibration gas requires:

1. Replacing the bottle and adjusting the regulator.
2. Entering the new gas values into TAS memory, if they do not match the old ones.
3. Performing the same calibration and leak test routine that is used in the Leak Calibration Test— item 1.

REPLACING THE BOTTLE

1. Unhook the elastic cord (1) and remove the bottle from the stand.
2. Close the bottle valve (2) by turning clockwise.
3. Remove the regulator (6) by loosening the regulator fitting (3).
4. Install the regulator on the new bottle and tighten the fitting.



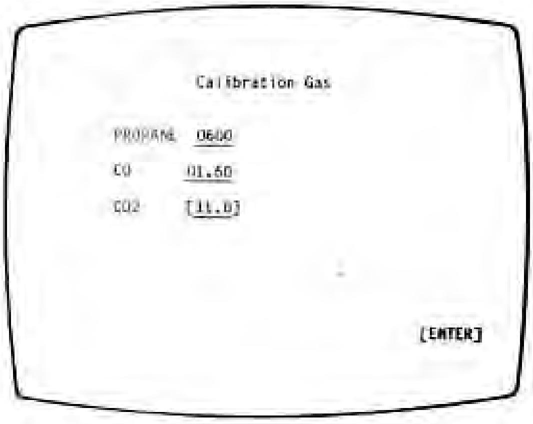
1. Elastic Cord
2. Bottle Valve
3. Fitting
4. Gauge
5. Hose
6. Regulator & Pressure Control Knob

5. Connect the regulator hose (5) to the port labeled "Cal Gas" on the TAS back panel.
6. Turn on the bottle valve and adjust the pressure control knob (6) until the gauge (4) reads 15 psi.
7. Compare the gas values of the empty bottle to the full one. If a value is different, the new gas value must be entered into TAS memory.
8. Mount and secure the new bottle to the stand.

The bottle change and regulator adjustment is completed.

ENTERING THE NEW GAS VALUES

- Press 3, then **ENTER**; to select Change Calibration Gas from the Service mode menu.



```
Calibration Gas

PROPANE  0600
CO       01.60
CO2     [11.0]

                         [ENTER]
```

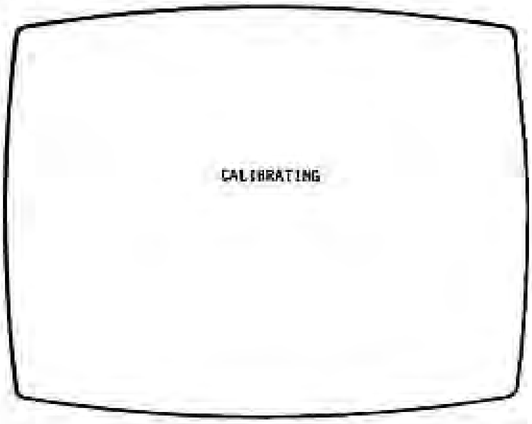
- Press **CLEAR** to erase the old propane value.
- Type in the new propane value, then press **ENTER**; to store the value and advance to the next item.
- Repeat this procedure (including decimals) for the remaining gas values.

The **Last** and **Next Entry** keys are activated for review.

- To omit changing the current values; press **ENTER** for each line.

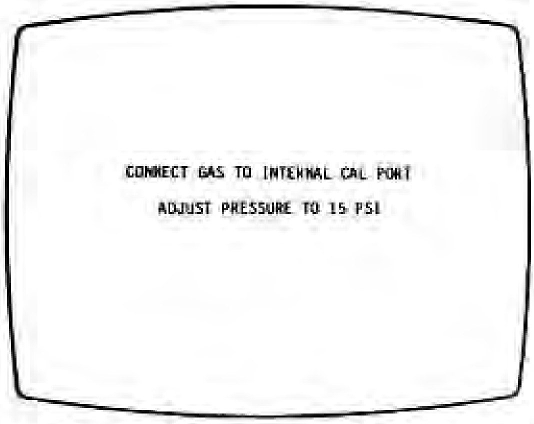
After the gas values are entered, calibration, leak check, and zeroing the bench begins.

CALIBRATION, LEAK CHECK, & ZEROING



```
CALIBRATING
```

Calibrating is briefly displayed. The test automatically proceeds.

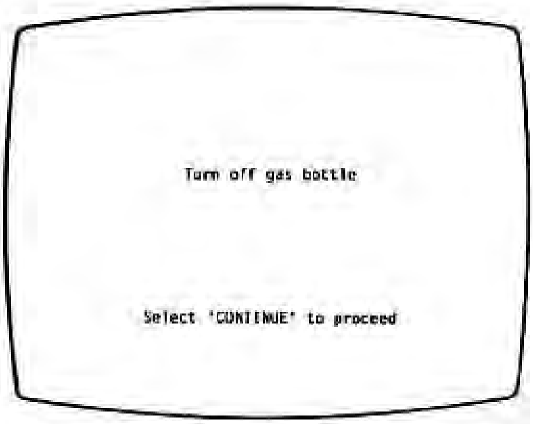


```
CONNECT GAS TO INTERNAL CAL PORT

   ADJUST PRESSURE TO 15 PSI
```

- Attach the gas bottle hose to the Cal Gas Port on the back of the TAS unit.
- Turn on the gas bottle valve.
- If necessary, adjust the pressure regulator to maintain 15 psi.

When proper pressure is sensed, Calibrating returns briefly. The test automatically proceeds.



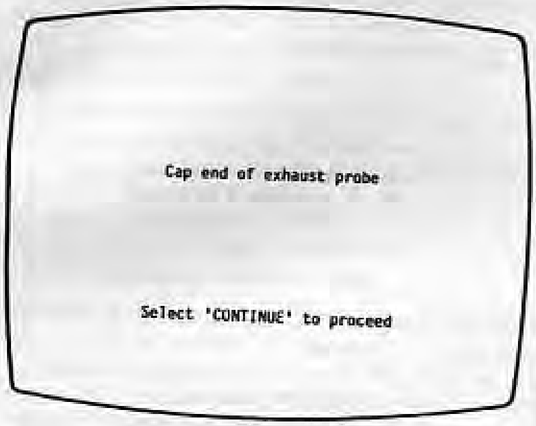
```
    Turn off gas bottle



Select 'CONTINUE' to proceed
```

- Turn off the gas bottle valve, then press **CONTINUE**.

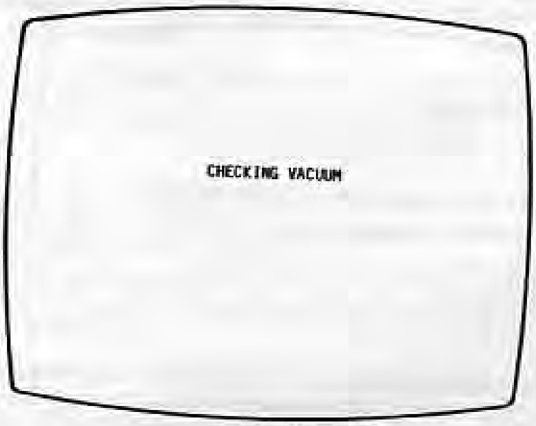
Calibration is complete and the Leak Test begins.



```
Cap end of exhaust probe

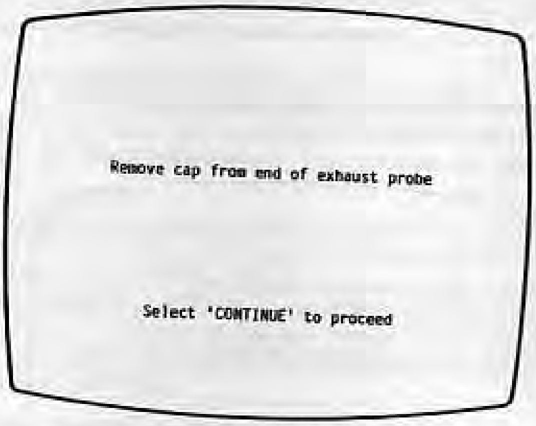
Select 'CONTINUE' to proceed
```

- Cap the end of the exhaust probe for the leak test, then press **CONTINUE**.



```
CHECKING VACUUM
```

Checking Vacuum is briefly displayed. The routine automatically proceeds.



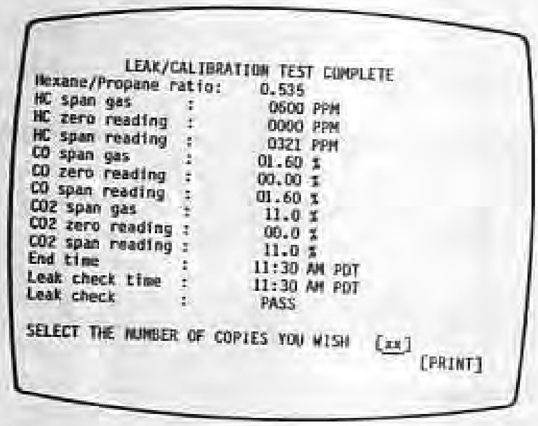
```
Remove cap from end of exhaust probe

Select 'CONTINUE' to proceed
```

- Take the cap off the end of the exhaust probe, then press **CONTINUE**.

The Leak Test is complete and Zeroing the Bench begins.

Zeroing Bench appears (60 sec.) while the bench zero setting is adjusted and the sample system flow is checked. Then, the test result is displayed.



```
            LEAK/CALIBRATION TEST COMPLETE
Hexane/Propane ratio:     0.535
HC span gas         :      0600 PPM
HC zero reading     :      0000 PPM
HC span reading     :      0321 PPM
CO span gas         :     01.60 %
CO zero reading     :     00.00 %
CO span reading     :     01.60 %
CO2 span gas        :      11.0 %
CO2 zero reading    :      00.0 %
CO2 span reading    :      11.0 %
End time            :     11:30 AM PDT
Leak check time     :     11:30 AM PDT
Leak check          :      PASS

SELECT THE NUMBER OF COPIES YOU WISH  [xx]
                                           [PRINT]
```

- Type in the number of printouts desired, then press **PRINT**; to print the result and return to the Service mode menu screen.

TEST RESULTS

Hexane to propane ratio: Must match the number on the p.e.f. tag located on the back of the TAS.

Span gas values: HC, CO and CO_2 must match the current bottle values entered during the bottle change.

Zero readings: HC, CO, and CO_2 are the zero settings for the bench.

Span readings: HC, CO and CO_2 are the span settings for the bench. CO and CO_2 should match the current bottle values.

The correct HC reading (hexane) is calculated by multiplying the current bottle's propane value by the propane equivalency factor (pef).

The pef number is slightly different for each analyzer. It is located on a round tag attached to the analyzer rear panel, and on a sticker on the bench assembly.

Example:

600 ppm propane
x .535 pef
321 ppm hexane

Leak check: Indicates the result of the leak test. If the leak test fails (FAIL) the Set-up screen will display a lockout.

Repair the leak (see Manual Operation—item 6, Operators Leak Test), then perform a Leak Test— item 5 to clear the lockout.

HC Hang-up Test—item 4

DESCRIPTION

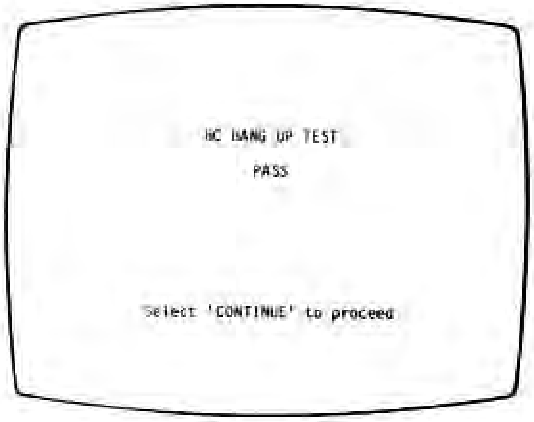
This routine checks if the HC bench registers more than 20 ppm while drawing room air through the exhaust sample circuit.

APPLICATION

This test can be used to manually check for an HC hang-up. An HC hang-up is caused by excessive residual HC in the sample circuit or the infrared bench zero calibration has drifted causing the meter to register more than 20 ppm, or both conditions. TAS prevents automated testing until the hang-up is cleared.

PROCEDURE

- Hang the exhaust probe on the TAS probe hook.
- From the Service mode menu press **4**,**then ENTER**; for HC Hang-up test.



```
HC HANG UP TEST

PASS

Select 'CONTINUE' to proceed
```

The words HC Hang-up Test are briefly displayed while TAS tests the HC level in the sample circuit.

The word Pass or Fail is displayed showing the test result.

- Press **CONTINUE** to proceed to the Service mode menu.

If the test fails, refer to PTC section 4—TAS Service mode, Manual Operation—item 6; to locate and repair the HC hang-up.

Leak Test—item 5

DESCRIPTION

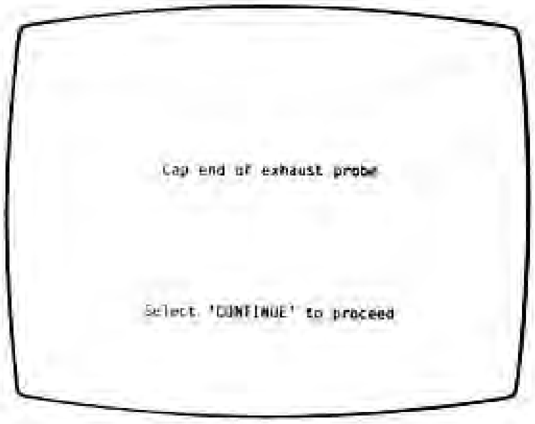
The Leak Test forms and holds a vacuum on the exhaust sampling system to check its integrity. If the Leak Test fails (FAIL), it will cause a "lockout" and set a message on the Malfunction screen.

APPLICATION

After repairs, use the Leak Test to clear the lockout and malfunction message. The Leak Test will substitute for the leak test portion of a Leak Calibration Test—item 1.

PROCEDURE

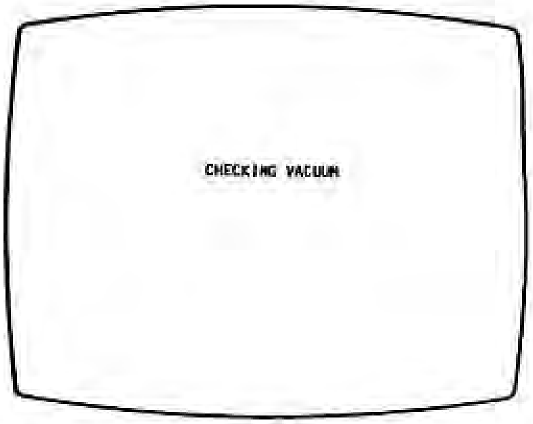
- Press 5, then **ENTER**; to select the Leak Test from the Service mode menu.



```
Cap end of exhaust probe

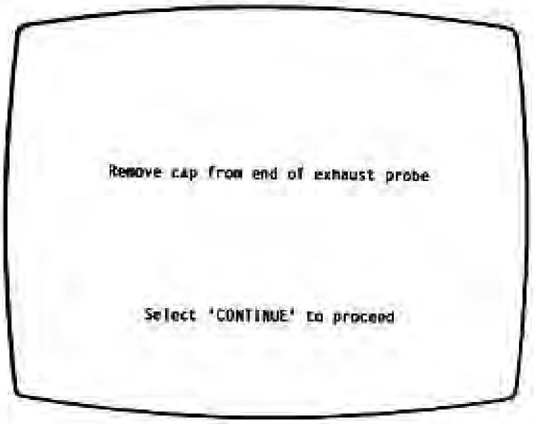
Select 'CONTINUE' to proceed
```

- Cap the end of the exhaust probe for the leak test, then press **CONTINUE**.



```
CHECKING VACUUM
```

Checking Vacuum is briefly displayed. The routine automatically proceeds.

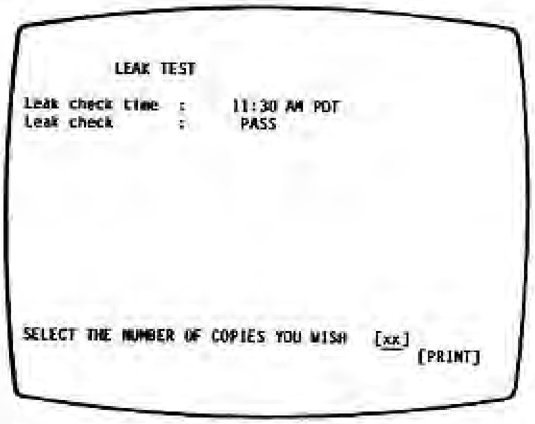


```
Remove cap from end of exhaust probe

Select 'CONTINUE' to proceed
```

- Take the cap off the end of the exhaust probe, then press **CONTINUE**.

The Leak Test is complete and the test result is displayed.



```
          LEAK TEST

Leak check time  :     11:30 AM PDT
Leak check       :      PASS

SELECT THE NUMBER OF COPIES YOU WISH  [xx]
                                          [PRINT]
```

The Result screen displays PASS or FAIL depending on the outcome of the leak test.

- Type in the number of printouts desired, then press **PRINT**; to print the result and return to the Service mode menu screen.

A failed test (FAIL) is caused by air leaks or pump trouble.

To check for air leaks; uncouple the exhaust hose at the filter bowl, cap the system at the "quick disconnect", and repeat the test.

If the test passes now, the leak is in the probe cap, tailpipe probe, or hose.

If the test still fails, check both filter bowls and exposed plumbing.

To pinpoint air leaks, see PTC section 4—TAS Service mode, Manual Operation—item 6, Operators Leak Test.

Manual Operation—item 6

APPLICATION

During a lockout, the Manual Operation screen is still available through the Service mode menu.

Use the Manual Operation screen to verify the accuracy and integrity of the gas sampling system.

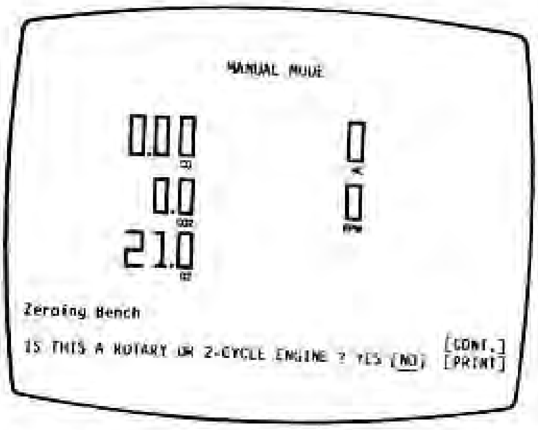
To perform a gas check; feed calibration gas into the Exhaust Probe port, then read the gas values on the Manual Operation screen.

The gas values displayed must match or be equivalent to those on the bottle sticker and within the percent deviation (5%) specified by the state.

The Manual Operation screen is also valuable to verify or locate HC hang-ups and air leaks is the sample system.

PROCEDURE

- Press **6**, then **ENTER**; to select Manual Operation from the Service mode menu.



Zeroing Bench

IS THIS A ROTARY OR 2-CYCLE ENGINE ? YES [NO] [CONT.] [PRINT]

The Manual Operation screen has displays for rpm, and four gases (HC, CO, CO_2, and O_2) if an oxygen option is installed and enabled. However, during a sample system check, rpm is not used.

Oxygen reads 21% (atmospheric) before gas is injected into the port, and 0% after because the calibration gases do not include O_2.

- Attach the calibration gas hose to the Exhaust Probe port.
- Turn on the gas bottle and observe the readings displayed.

The HC, CO, and CO_2 readings must be within the percent deviation (5 %) allowed by the state.

CO and CO_2 will match the bottle values while HC reads an equivalent hexane value.

The correct HC reading (hexane) is calculated by multiplying the current bottle's propane value by the propane equivalency factor (pef).

The pef number is slightly different for each analyzer. It is located on a round tag attached to the analyzer rear panel and on a sticker on the bench assembly.

Example:

600 ppm propane
x .535 pef
321 ppm hexane

For this example, the HC must read 321 ppm plus or minus the percent deviation allowed by the state.

- To receive a printout of the gas values, press **PRINT**.
- To return to the Service mode menu without printing; press **CONTINUE**.

HC Hang-up Diagnosis

DESCRIPTION

Access to the Manual Operation screen through the Service mode is valuable to verify and locate HC hang-ups in the analyzer's gas sampling system. The Manual Operation screen displays the gas values sensed through the exhaust probe and hose assembly.

An HC hang-up is caused by excessive residual HC in the sample circuit or the infrared bench zero calibration has drifted causing the meter to register more than 20 ppm, or both conditions.

The TAS purges the system with room air in an effort to clear the HC from the sample circuit. Hang the exhaust probe four feet above the shop floor to avoid gas vapors and ensure efficient purging.

Identify if a residual HC and/or a zero drift problem exist. HC problems must be corrected before a zero drift problem.

RESIDUAL HC PROCEDURE

A residual HC problem is characterized by a HC reading that slowly diminishes in value as purging continues. It is caused by saturated components in the exhaust sample circuit and is corrected by additional purge time or cleaning/replacement of the offending component, once it is located.

To locate the HC source use the process of elimination.

- From the Service mode menu, press **6**, then **ENTER**; to display the Manual Operation screen.
- Uncouple the probe hose from the filter assembly; to isolate the hang-up. See if the HC value shows a considerable reduction.
- If it does, flush the probe hose with warm soapy water, rinse, blow dry and retest.
- If it does not, service the filter system and retest.
- If the HC value is still diminishing slowly but is excessively high, the residual HC can be in the pump or other internal components. Call for a TAS service technician, or allow additional purge time.
- If the remaining HC value is fixed (does not diminish with purging) it is likely to be caused by a zero drift.

ZERO DRIFT PROCEDURE

Zero drift is characterized by a fixed HC reading during purging. It occurs through normal use and is corrected by automatic or manual zeroing of the bench. The bench is automatically zeroed during Warm-up and some operating modes, however it can be manually zeroed by pressing the

Zero Bench key with the Manual Operation or Set-up screens displayed.

- From the Manual Operation screen, press **ZERO BENCH** to clear any zero drift.

Operator's Leak Test

APPLICATION

The Manual Operation screen can also be used to pinpoint air leaks in the suction side of the exhaust sample system. Air leaks can cause a lockout, set a Leak Test Failure and Bad Vacuum malfunction message, and trigger a CO_2 Dilution Error prompt if the leak is large enough.

PROCEDURE

- From the Service mode menu, press **6**, then **ENTER**; to display the Manual Operation screen.
- Cap the end of the exhaust probe to draw a vacuum on the sample system.
- Use an alcohol (isopropyl) soaked cotton swab to trace along the surface of the sample circuit. Pause about 10 seconds at each location and watch for the HC increase to indicate an air leak.

  An analyzer testing the vapors emanating from an open bottle of isopropyl alcohol can read over 600 ppm of hydrocarbons. Unless a leak in the system is severe, the readings will be much lower.
- Check the following joints and components for leaks. Repair as needed.

1. The probe flexible section, and the probe joints (flex tip to probe, and probe to hose).
2. The hose, and the male coupler to hose joint.
3. The street elbow threads at the female "quick coupler" and filter bowl. All threaded couplings should be Teflon taped for maximum sealing.
4. Around the gasket that seals the top of the filter bowl to the filter head.

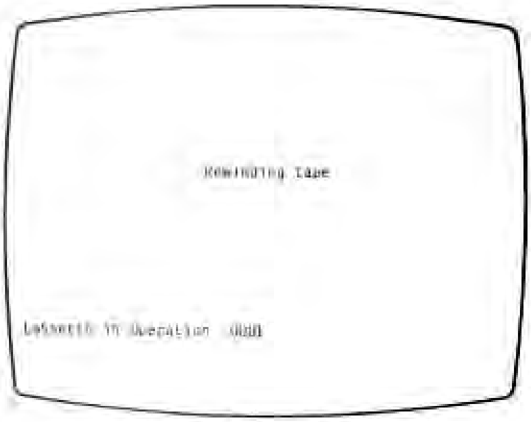
New Tape—item 7

APPLICATION

This routine will write the software program stored in analyzer's RAM (memory) onto a new blank tape. Use this procedure to change the tape for state data collection.

PROCEDURE

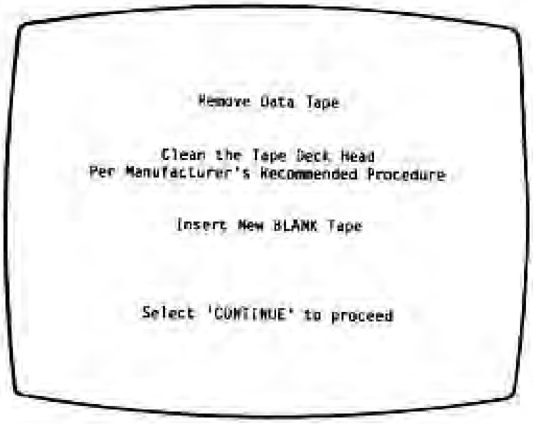
- Press 7, then **ENTER**; to select the New Tape routine from the Service mode menu.



```
Rewinding Tape

Cassette in Operation : 0001
```

This screen appears while the tape is rewinding to the start position.



```
Remove Data Tape

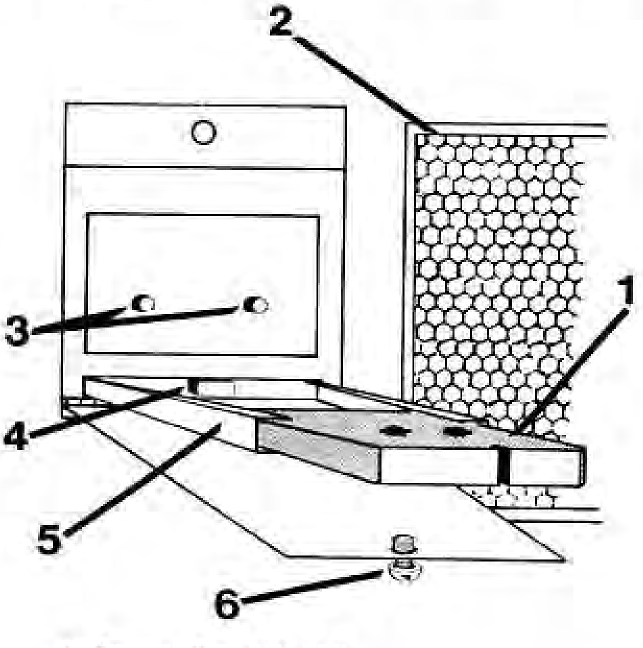
Clean the Tape Deck Head
Per Manufacturer's Recommended Procedure

Insert New BLANK Tape


Select 'CONTINUE' to proceed
```

- Change the tape.

1. Open the access door (6) on the TAS back panel.
2. Press and release the tape drive door (5), then remove the cassette tape (1).
3. Clean and dry the tape head (4) using cotton swabs and rubbing alcohol. For complete head cleaning instructions, see PTC section 5—TAS Maintenance, Head Cleaning.

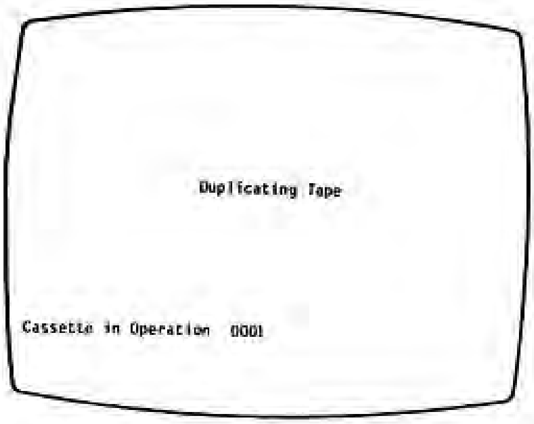


1. **Cassette Tape Side "B"**
2. **Air Inlet Filter**
3. **Tape Drive Splines**
4. **Head**
5. **Tape Drive Door**
6. **Access Door & Fastener**

4. Insert the new blank tape with the ribbon down against the head and side "B" facing the tape drive splines. Do not insert a tape that has vehicle tests recorded on it. Close the tape drive door, then close and fasten the access door.

- Press **CONTINUE** to begin recording the program onto the tape.

If the old tape contains vehicle tests, submit it for state data collection.



```
Duplicating Tape

Cassette in Operation  0001
```

Cassette in Operation appears briefly, then Duplicating Tape appears while the program is recorded onto the tape. Recording can take 20 minutes.

When the tape duplication is complete, the Service mode menu returns.

- Press **0**, then **ENTER**; to return to the Set-up screen.

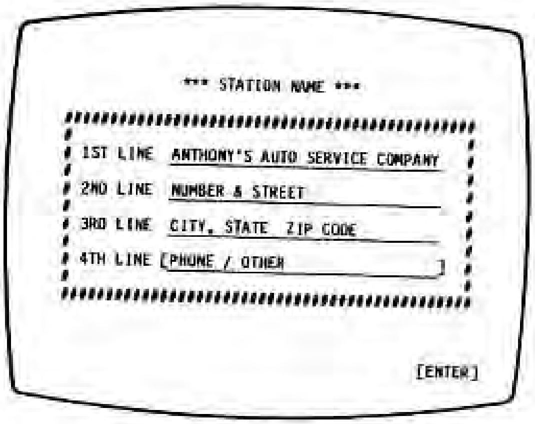
Service Station Name Entry—item 8

APPLICATION

This procedure programs the business name or other desired data to appear on the printout.

PROCEDURE

- Press **8**, then **ENTER**; to select the Station Name screen from the Service mode menu.



```
*** STATION NAME ***

###############################################
#                                             #
# 1ST LINE  ANTHONY'S AUTO SERVICE COMPANY    #
#                                             #
# 2ND LINE  NUMBER & STREET                   #
#                                             #
# 3RD LINE  CITY, STATE  ZIP CODE             #
#                                             #
# 4TH LINE [PHONE / OTHER                  ]  #
#                                             #
###############################################

                                       [ENTER]
```

- Type the business name into the first line. When correct, press the **ENTER** key to store the data and advance the to the next line.
- Repeat this procedure with other desired data for lines 2, 3 and 4.

When the last entry is completed, the Service mode menu is displayed.

- To omit changing an existing entry; press **ENTER** for each line.
- To erase, use the **Clear** or **Delete** keys. To review entries, use the **Last Entry** or **Next Entry** keys.

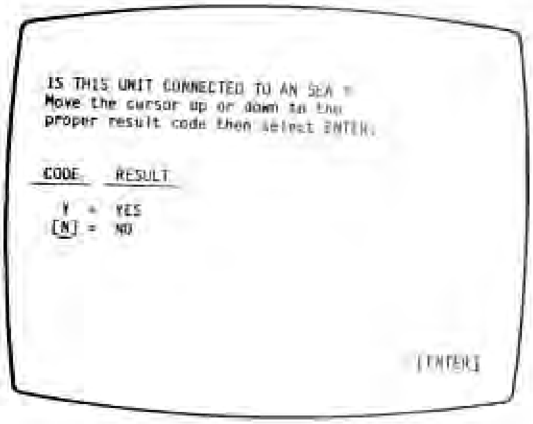
Enable Network—item 9

APPLICATION

With the appropriate features, the EPA Emission Analyzer can be "Networked" to communicate with a Smart Engine Analyzer (SEA). This procedure activates the "Network" function and establishes communication through the RS 232 connector on each analyzer.

PROCEDURE

- Press **9**, then **ENTER**; to select the Enable Network screen from the Service mode menu.



```
IS THIS UNIT CONNECTED TO AN SEA ?
Move the cursor up or down to the
proper result code then select ENTER.

 CODE    RESULT

  Y  =  YES
 [N] =  NO

                                   [ENTER]
```

- To activate the Network Diagnostic mode; select **Y** (yes), using the **Cursor** keys, then press **ENTER**.
- To activate the Smart Diagnostic mode; select **N** (no), using the **Cursor** keys, then press **ENTER**.
- From the Service mode menu, press **0**, then **ENTER**; to return to the Set-up screen.

The Set-up screen will display Smart or Network mode, depending on the selection.

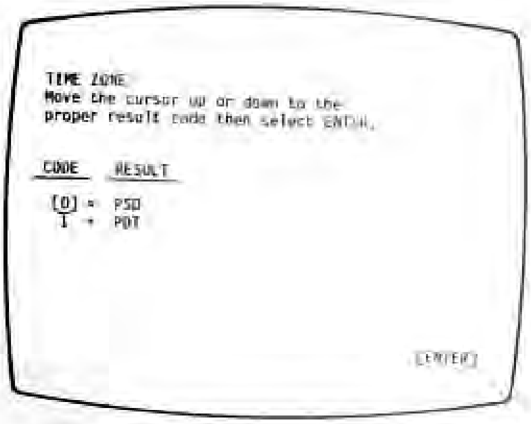
Time Zone—item 10

APPLICATION

This routine is used for those states that participate in Daylight Savings Time. The TAS clock may be set ahead one hour in the Spring and set back to the Standard Time in the Fall.

PROCEDURE

- Press **10**, then **ENTER**; to select the Time Zone screen from the Service mode menu.



```
TIME ZONE
Move the cursor up or down to the
proper result code then select ENTER.

 CODE    RESULT

 [0] =  PSD
  1  =  PDT

                                   [ENTER]
```

When the Spring or Fall day arrives to reset the clocks, be sure to change the time before running the next vehicle certification test.

- To "Fall back" one hour to Standard Time; select **0**, using the **Cursor** keys, then press **ENTER**.
- To "Spring Forward" one hour to Daylight Savings Time; select **1**, using the **Cursor** keys, then press **ENTER**.

When the routine is completed, the Service mode menu is displayed.

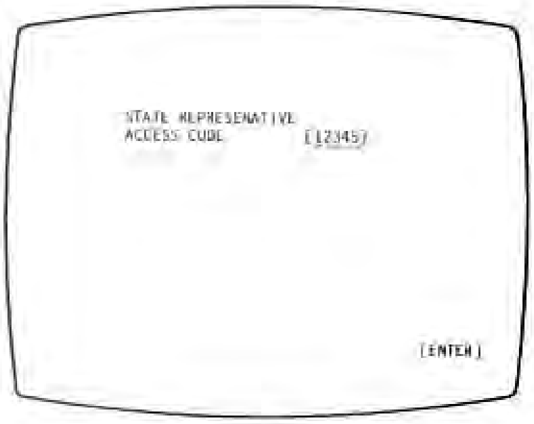
State Representative's Access Code —item 11

APPLICATION

This procedure programs the state representative's access code into TAS memory. The state representative can access Service mode menu items 0, and 11-17.

PROCEDURE

- Press **11**, then **ENTER**; to select the Representative's Access Code screen from the Service mode menu.



```
STATE REPRESENATIVE
ACCESS CODE          [12345]




                               [ENTER]
```

- Type in up to five numbers, then press **ENTER**; to store the code and return the Service mode menu.
- To omit changing an existing entry; press **ENTER**.
- To erase, use the **Clear** or **Delete** keys.

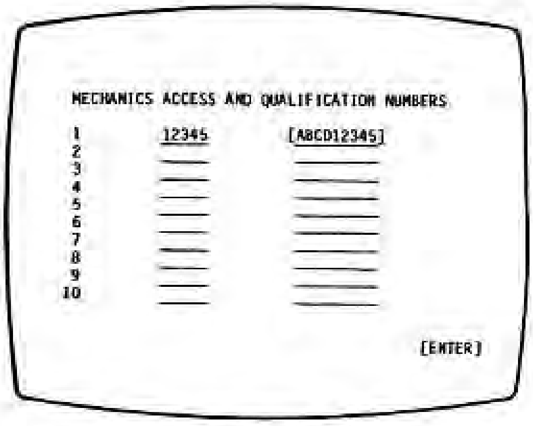
Mechanic's Access Code—item 12

APPLICATION

This procedure enters the access code and qualification number, for 10 mechanics into TAS memory. The qualification number appears on the printout. Mechanics can access menu items 0-6.

PROCEDURE

- Press **12**, then **ENTER**; to select Mechanics Access Code screen from the Service mode menu.



```
MECHANICS ACCESS AND QUALIFICATION NUMBERS

1        12345         [ABCD12345]
2        _____         ___________
3        _____         ___________
4        _____         ___________
5        _____         ___________
6        _____         ___________
7        _____         ___________
8        _____         ___________
9        _____         ___________
10       _____         ___________

                                   [ENTER]
```

- Type in up to five **Numeric** characters, then press **ENTER**; to finish the code and advance to the qualification number.
- Type in up to nine **Alphanumeric** characters, then press **ENTER**; to store the qualification number.
- Repeat this procedure for the remaining entries.

When the last entry is completed, the Service mode menu is displayed.

- To omit changing an existing entry; press **ENTER**.
- To erase, use the **Clear** or **Delete** keys. To review entries, use the **Last Entry** or **Next Entry** keys.

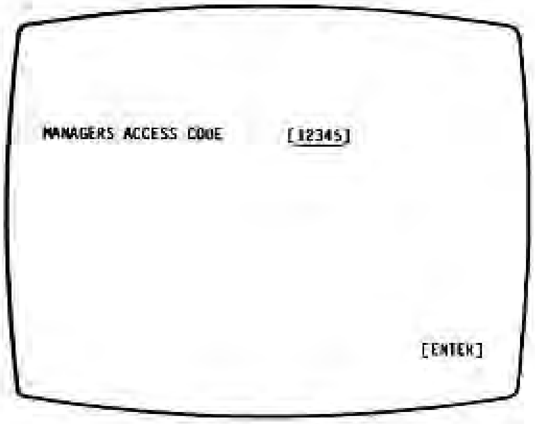
Manager's Access Code—item 13

APPLICATION

This procedure programs the manager's access code. The manager can access Service mode menu items 0-10.

PROCEDURE

- Press **13**, then **ENTER**; to select the Manager's Code screen from the Service mode menu.



```
MANAGERS ACCESS CODE        [12345]




                                   [ENTER]
```

- Type in up to five **Numeric** characters, then press **ENTER**; to store the code and return the Service mode menu.
- To omit changing an existing entry; press **ENTER**.
- To erase, use the **Clear** or **Delete** keys.

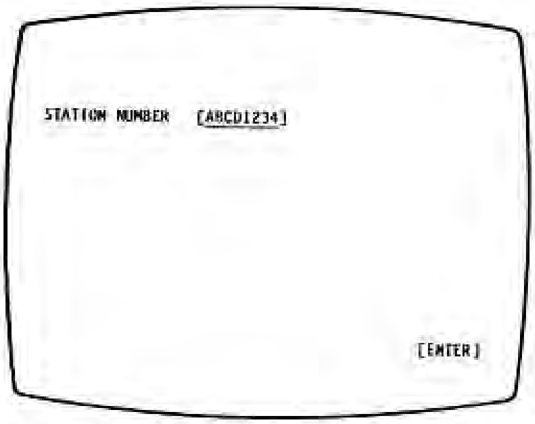
Station Number—item 14

APPLICATION

This procedure programs the station number to appear on the printout and to be displayed on the Unit Malfunction screen.

PROCEDURE

- Press **14**, then **ENTER**; to select Station Number from the Service mode menu.



```
STATION NUMBER  [ABCD1234]

                                [ENTER]
```

- Type in up to eight alphanumeric characters, then press **ENTER**; to record the data and return to the Service mode menu.

Nominal Gas Values—item 15

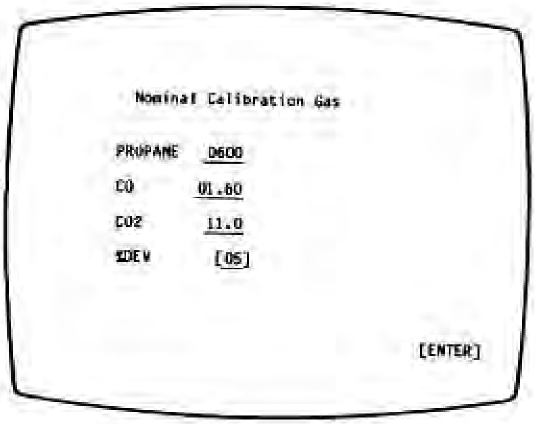
APPLICATION

This procedure programs the state's nominal gas specification into TAS memory. The value of the reference gases (see bottle label) used for calibration must not deviate more then 5% from the state's values in TAS memory. At the time of this writing the values are:

HC = 600 ppm hexane
CO = 1.60 %
CO_2 = 11.0 %
Deviation = 5 %

PROCEDURE

- Press **15**, then **ENTER**; to select Nominal Gas Values from the Service mode menu.



```
   Nominal Calibration Gas

PROPANE   0600
CO        01.60
CO2       11.0
%DEV       [05]

                              [ENTER]
```

- Press **CLEAR** to erase the old propane value.
- Type in the new propane value, then press **ENTER**; to store the value and advance to the next item.
- Repeat this procedure (including decimals) for the remaining gas values.
- To omit changing the current values, press **ENTER** for each line.
- After the gas values and deviation are entered, the Service mode menu returns.

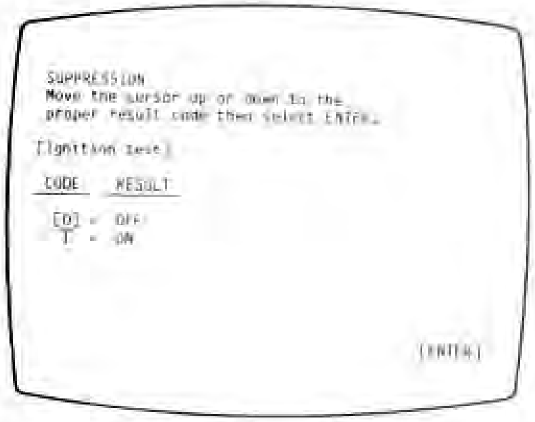
Screen Suppression—item 16

DESCRIPTION

This procedure activates additional screens and tailors the TAS program to the state's needs. Suppressed screens will not appear.

PROCEDURE

- Press **16**, then **ENTER**; to select Screen Suppression from the Service mode menu.



```
SUPPRESSION
Move the cursor up or down to the
proper result code then select ENTER.

[Ignition test]

 CODE   RESULT

 [0] =  OFF
  1  =  ON

                              [ENTER]
```

- To activate the screen; select **1** (on), using the **Cursor** keys, then press **ENTER**.
- To suppress the screen; select **0** (off), using the **Cursor** keys, then press **ENTER**.
- Repeat this procedure for each suppression item.

Suppression items:

1. Referee station.
2. Ignition test.
3. EGR test.
4. State approval number.

When the last item is done, the Service mode menu is displayed.

Gas Check—item 17

APPLICATION

Used Gas Check to audit the accuracy and integrity of the gas sampling system.

The operator can choose the gas path (gas entry port) to the infrared bench, feed calibration gas into the selected port, then read the gas values on the Manual Operation screen.

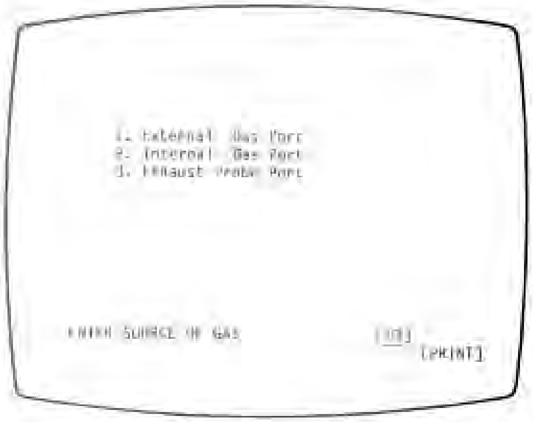
The gas values displayed (HC, CO, and CO_2) must match or be equivalent to those on the bottle sticker and within the percent deviation (5%) specified by the state.

During a port-to-port comparison of a calibration gas (HC, CO, or CO_2), the gas should read an identical value regardless of the entry port.

The Manual Operation screen is also valuable to verify or locate HC hang-ups and air leaks in the sample system when all other modes are locked out. See PTC section 4—TAS Service mode, Manual Operation—item 6; to pinpoint air leaks and HC hangups.

PROCEDURE

- Press 17, then **ENTER**; to select Gas Check from the Service mode menu.



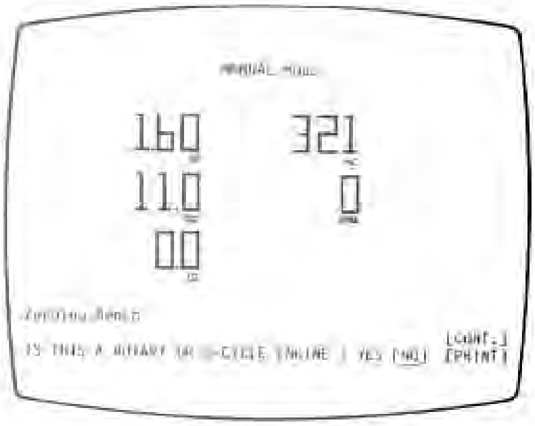
1. External Gas Port
2. Internal Gas Port
3. Exhaust Probe Port

ENTER SOURCE OF GAS

- Type in the number corresponding to the gas port to be checked, then press **ENTER**.

The gas ports are located on the back of the analyzer and labeled as follows.

TAS Back Panel		Monitor Screen
Service Use Only	=	1. External Gas Port
Cal Gas	=	2. Internal Gas Port
Inlet	=	3. Exhaust Probe Port



IS THIS A ROTARY OR 2-CYCLE ENGINE ? YES [NO]

The Manual Operation screen has displays for rpm, and four gases (HC, CO, CO_2, and O_2) if an oxygen option is installed and enabled. However, during a Gas Check rpm is not used.

Oxygen reads 21% (atmospheric) before gas is injected into the port, and 0% after because the cal gases do not include O_2.

- Attach the calibration gas hose to the selected port.
- Turn on the gas bottle, adjust the pressure, and observe the readings displayed.

The HC, CO, and CO_2 readings must be within the percent deviation (5 %) allowed by the state.

CO and CO_2 will match the bottle values while HC reads an equivalent hexane value.

The correct HC reading (hexane) is calculated by multiplying the current bottle's propane value by the propane equivalency factor (pef).

The pef number is slightly different for each analyzer. It is located on a round tag attached to the analyzer rear panel, and on a sticker on the bench assembly.

Example:

600 ppm propane
x .535 pef
321 ppm hexane

For this example, the HC must read 321 ppm plus or minus the percent deviation allowed by the state.

- To receive a printout of the gas values; press **PRINT**.
- To return to the Service mode menu without printing; press **CONTINUE**.
- If needed, repeat the Gas Check procedure for the remaining ports.

FAULT/HELP PROMPTS

The following Fault prompts can be displayed during the TAS Service mode procedures.

INVALID ACCESS CODE: Appears when entering the wrong access code. The routine aborts to the Set-up screen. Further progress is rejected until the operator enters an access code the analyzer recognizes.

OUT OF NOMINAL RANGE: Appears if unacceptable gas values are entered during a Change Calibration Gas procedure. The reference gas used for calibration and the values entered must comply with the state's nominal gas specification in the TAS memory.

INSTALL BACKUP PROGRAM PRESS CONTINUE WHEN READY: Indicates the TAS is having trouble reading, or writing to the data tape. Restart Warm-up or try another program tape.

UNIT TAMPERED/TAPE NOT CHANGED: Appears during a tape change and indicates the cassette door was opened but the tape was not changed. Repeat the procedure correctly.

TAPE DOOR OPENED: Indicates the tape door is open. Close the door.

TAPE IN BACKWARDS: Indicates the tape is installed wrong. Side "B" must engage the tape drive splines first when the cassette door is closed.

TAPE WRITE PROTECTED: Indicates that the erase prevention tabs on the cassette tape are gone or in the wrong position, thus TAS cannot record. Install another new tape if the tabs are gone.

TAPE READ/WRITE ERROR: Can appear during a tape change. Indicates data cannot be stored onto or recovered from the tape. Clean the recorder head and install the correct new tape (blank or preprogrammed).

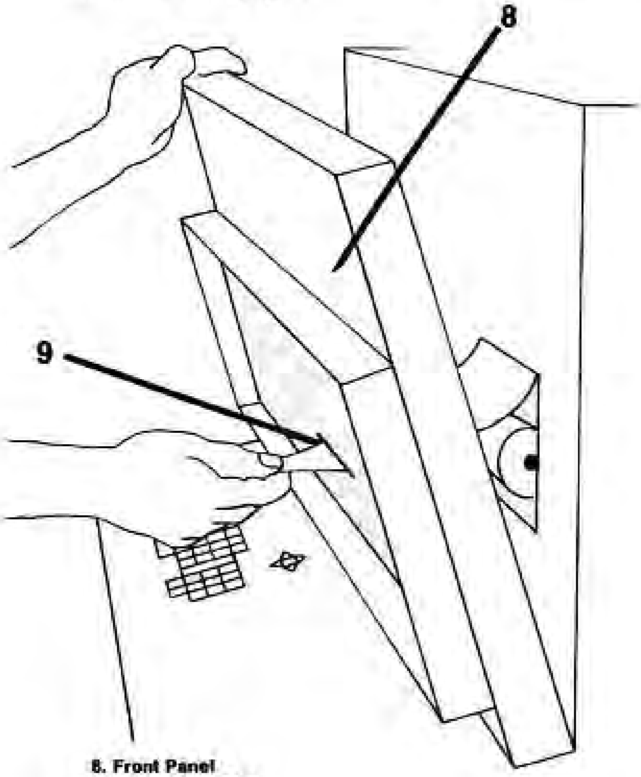
BAD TAPE: Appears during a tape test if the tape is defective. Clean the tape recorder head and install the correct new tape (blank or pre-programmed). See PTC section 4—TAS Service mode, New Tape—item 7.

SECTION 5
ANALYZER MAINTENANCE PROCEDURES

This section covers the maintenance required to keep the TAS operating efficiently. Follow the recommended service intervals listed on the Maintenance Schedule.

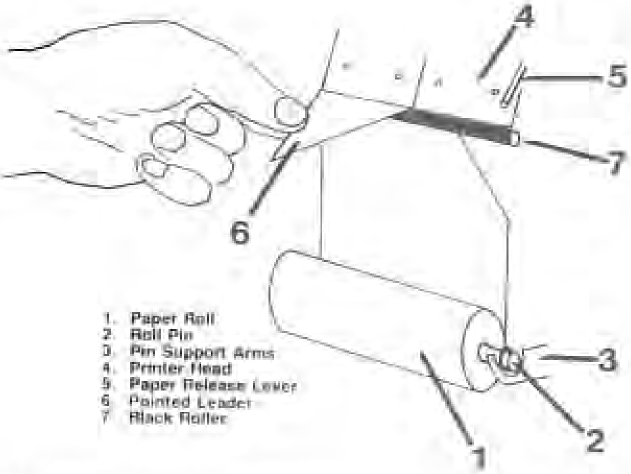
CHANGING PRINTER PAPER

1. Grasp front panel (8) at the top and pull forward to lower the panel.
2. Raise the paper release lever (5) to lift the printer head (4) and release paper.



8. Front Panel
9. Paper Feed Slot

3. Lift the roll (1), remove roll pin (2), and pull out any leftover paper.
4. Place a new roll on the pin and install in the pin support arms (3). The paper should feed upwards from the back of the roll.
5. Fold a point (6) on the leading edge of the new roll. This aids in starting the new roll into the printer.
6. Insert pointed end of the paper just behind the black roller (7) and push upward until the paper appears from under the printer head (4).
7. Carefully pull out the paper about 12 inches for a leader (6), then press the printer lever down to engage the printer head. The printer will not print if the lever is left up.
8. Press the **Feed** key several times and check for smooth paper feeding.
9. Pass the paper leader through the front panel slot (9).
10. Close the front panel and pull the slack out of the paper.



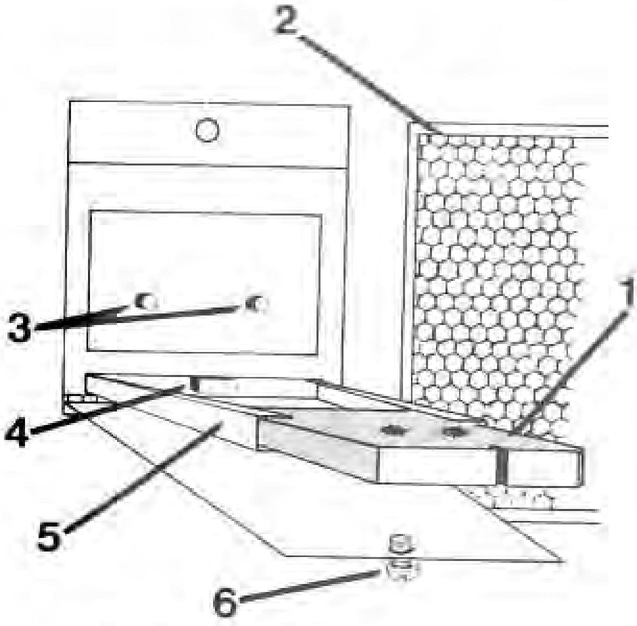
1. Paper Roll
2. Roll Pin
3. Pin Support Arms
4. Printer Head
5. Paper Release Lever
6. Pointed Leader
7. Black Roller

TAPE RECORDER HEAD

Inspect and clean the tape recorder head during each tape change or when dirty. The tape cassette can be removed without violating TAS security, if the same tape is reinstalled.

CLEANING

1. Open the access door (6).
2. Press and release the tape drive door (5), then remove the cassette tape (1).
3. Clean the head (4) with a cotton swab and rubbing alcohol or any good commercial head cleaning solution.



1. Cassette Tape Side "B"
2. Air Inlet Filter
3. Tape Drive Splines
4. Head
5. Tape Drive Door
6. Access Door & Fastener

4. Dry the head with a new swab. Wait a few minutes for the alcohol to evaporate.
5. Insert the tape, ribbon side down against the head, and side "B" facing the tape drive splines (3).
6. Close the tape drive door, then close and fasten (6) the access door.

AIR INLET FILTER

DESCRIPTION

The filter element is a synthetic sponge sandwiched between two metal grates. This assembly slides into the rectangular filter housing which is part of the analyzer's back panel. Air from the inlet is directed through the bench heater to stabilize the bench readings, and over the circuit boards for cooling. A dirty filter element restricts air flow and can cause overheating and unstable conditions within the gas bench or electronic circuits.

CLEANING

1. Uncouple the hose from the Primary filter assembly. Then, slide out the filter "sandwich". This step uncovers the Secondary filter assembly (water separator). Inspect the secondary filter at this time.
2. Wash the sponge in warm soapy water, rinse, and squeeze dry or blow dry with low pressure compressed air.
3. Reassemble and slide the assembly back into the filter housing.

CABINET, KEYBOARD, AND LEADS

Clean using a commercial spray cleaner (Formula 409 or Fantastik) mixed 1:1 with water.

PLEXIGLASS WINDOW AND CRT

Use a commercial window cleaner mixed 1:1 with water. Wash on both sides of the panel. Do not use abrasive cleaners or scouring pads.

BANNER LAMP

Open the front panel to replace a burned out banner lamp with a 36-inch fluorescent tube.

EXHAUST HOSE AND PROBE

A restricted exhaust hose assembly can cause poor analyzer response time and low flow faults.

CLEANING

1. Remove the male coupler and tailpipe probe from the hose.
2. Use a small drill bit or torch tip cleaners to remove carbon from the probe tip holes. Avoid enlarging the holes.
3. Blow compressed air through the probe holes and hose to remove dirt and restrictions.
4. Crimp a small round split-shot sinker onto a fishing line and blow it through the hose. Watch where the muzzle end of the hose is pointed. Remove the sinker and tie a small rifle brush or swab onto the line. Tie a line to the other end of the brush. Pull the brush back and forth to scrub the inside of the hose. Remove the brush and blow out loosened dirt.
5. If necessary, flush with soap and water, rinse and blow dry.
6. Reassemble the coupler, hose, and probe.

SAMPLE SYSTEM FILTERS

DESCRIPTION

The Primary filter assembly protects the Pump and Optical Bench assemblies by trapping exhaust dirt and carbon particles larger than 5 microns. Particles larger than 30 microns are stopped by the outer surface areas of the fiber element; successively smaller particles are caught as the exhaust gas sample is drawn inward through the element.

The Secondary filter assembly (water separator) collects the normal water vapor produced during combustion, and contains a 75 micron stainless steel filter element. Water is drawn from the bowl, through the wet side of the pump, and exits through the drain hose on the back panel. Remove the Air Inlet filter to access the Secondary filter assembly.

Each sample filter is enclosed in a high-strength polycarbonate bowl that is not affected by normal chemicals in the exhaust. However, carburetor cleaner and some parts cleaning solvents can damage the plastic.

Since the filter assemblies are on the inlet (vacuum) side of the pumps, it is important to perform a leak test after a filter change. See PTC section 4—TAS Service mode, Leak Test—item 5. To pinpoint air leaks, see PTC section 4—TAS Service mode, Manual Operation—item 6, Operator's Leak Test.

CLEANING

The Primary filter element is not cleanable. Replacement is determined by the number of test performed, and the condition of the exhaust. Vehicles that produce heavy clouds of soot will clog the filter quickly. Vehicles that emit excessive hydrocarbons (raw fuel) can saturate the filter element and cause inaccurate test results, or an HC hang-up.

Replacement of the whole Primary filter assembly is likely after several years of exposure to the caustic elements of automotive exhaust. If this is necessary, be sure to install the filter assembly with the arrow on top pointing in the direction of the exhaust sample flow. This configuration causes the incoming sample to be pulled from the outside of the element to the inside, for maximum analyzer protection.

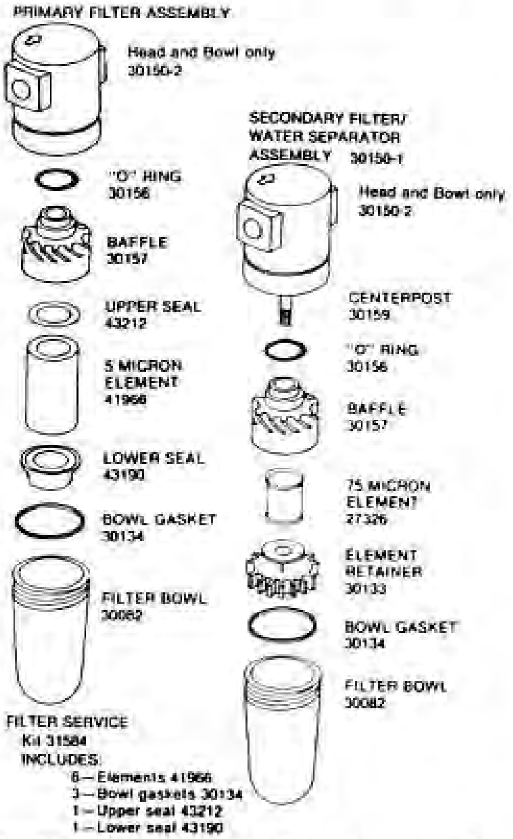
To clean the Secondary filter element, spray it with a brake cleaner product (trichloroethane), wash with soap and water, rinse and blow dry. Make sure the element is free of a heavy hydrocarbon smell; the analyzer can smell it too.

FILTER ELEMENT REPLACEMENT

There are several small parts to keep track of when removing the filter element. Spare parts are recommended.

1. Separate the plastic hose from the elbow on the filter bowl.
2. Remove the bowl by turning counter clockwise as viewed from the bowl bottom.
3. Remove the internal components. For Secondary filters, unscrew the element retainer first.
4. Check for missing or damaged parts. All seals, gaskets, and filter elements must be reinstalled to prevent bench contamination (damage) and prevent air leaks (inaccurate tests).
5. Clean the internal components, then lubricate the seals. For Primary filters, replace the fiber element.
6. Install the assembled baffle and O-ring.
7. Install the remaining internal components. For Primary filters, install the lower seal onto the element to ensure proper sealing. Insert the element into the bowl and set the upper seal on the element.

8. Install the bowl gasket onto the bowl.
9. Install the bowl. Do not cross-thread the bowl. It takes 4¼ turns after initial thread engagement to seal the bowl. If it tightens in one turn, the bowl or gasket is misaligned.
10. Align the bowl elbow and install the plastic hose.
11. Perform a leak test.



ALTERNATE METHOD OF INSTALLING THE FILTER BOWL TO AVOID LEAKS

It can be difficult to feel the gasket compress when installing the filter bowls. This is because the filter element and the associated internal parts need to be squeezed before the bowl gasket compresses to seal against air leaks.

The thickness of the bowl gasket affords about a ¾ turn "window" between initial contact and damage due to overtightening. If the bowl is too loose; air leaks past the gasket and causes sample dilution, or exhaust leaks past the filter element and damages the bench. Overtightening can cause a ruined bowl gasket or a stuck bowl.

The following bowl tightening procedure is effective when the bowl screws in easily. If it will not screw in easily, align/clean/replace the offending part, or disregard this method of tightening the bowl and merely tighten the bowl 4¼ turns after initial thread engagement.

After removing and cleaning all the internal components, install just the filter bowl (no gasket or filter).

1. The bowl should screw in easily to the bottom of its threads.
2. Make a small alignment mark on the bowl and the metal housing above it. Next to the line, mark an "F" on the bowl for full crush. If the bowl is tightened this far with the gasket installed, the gasket will be destroyed.
3. Remove the bowl. Lubricate the gasket with a non petroleum based lubricant and install the gasket on the bowl. Thread it in until it lightly bottoms. This can be felt as a slight increase in turning resistance. Make another alignment mark on the bowl directly under the housing mark. Label this bowl line with an "I" for initial contact. You now have two marks on the bowl and one on the housing. The ideal sealing will occur approximately half way between initial contact (I) of the gasket and full crush (F).
4. Remove the bowl and install all the internal components.
5. Install the bowl being careful not to cross thread the bowl. The bowl should thread easily the first couple turns. Start looking for the "I" mark on the bowl once resistance is felt from the compression of the internal parts.
6. Continue to turn the bowl until the "I" mark passes the alignment mark on the housing. Continue to turn until about half way to the "F" mark.

This procedure should provide efficient sealing, minimal gasket damage and no stuck filer bowls.

BENCH OUTLET AND WATER DRAIN PORTS

DESCRIPTION

The analyzer's sample system has exhaust gas, and water separator circuits. These circuits have separate pumps (dry, wet) mounted at opposite ends of a shared motor.

Exhaust gas is moved by the dry pump through the primary filter, condenser, secondary filter, dry pump, and bench before it exits at the port labeled "outlet".

Water is drawn from the bottom of the primary and secondary filters by the wet pump before it exits at the port labeled "drain".

INSPECTION

The "drain" and "outlet" ports are located on the analyzer back panel below the primary filter. A short hose extends from each port to the atmosphere. Periodically inspect the hoses for restrictions, and never blow air into or join them. Excessive pressure within their systems will damage the bench.

OXYGEN SENSOR

DESCRIPTION

The EPA Emission Analyzer will measure the oxygen (O_2) content of the vehicle exhaust if an oxygen sensor option is installed and enabled. The sensor is located in the outlet stream of the infrared bench. The gas sample enters the infrared bench where it is measured for carbon monoxide (CO), hydrocarbons (HC), and carbon dioxide (CO_2), then it goes to the O_2 sensor.

An oxygen sensor is a galvanic electro chemical device. It produces a small current, proportional to the amount of oxygen surrounding its sensing surface.

Internally the sensor works like a battery, developing voltage from dissimilar electrode materials in a water base electrolyte. Like all batteries, the materials in the O_2 sensor limit its life expectancy.

Sensor material life is affected by exposure (frequency, duration, and concentration) to oxygen, acidic gases, and extreme heat and cold.

Atmospheric air entering the engine contains 21% O_2. Engine exhaust contains .1% to 12% O_2 (depending on the condition of the engine system), plus acidic gases (CO_2, NOx).

Exhaust temperature at the tailpipe is around 600°F, however, by the time it reaches the infrared bench its at room temperature. The bench heater then warms the sample slightly before it reaches the sensor. When the analyzer is turned off the sensor temperature depends on the shop environment—the sensor will freeze at 26°F.

Depending on exposure, the sensor will generally last about one year and therefore should be considered a consumable item.

CONSIDERATIONS

Oxygen sensors used in Allen equipment represents the latest technology and best solution to design considerations like operating environment, materials available, response time, accuracy, life expectancy, and cost.

To realize maximum sensor life the operator should:

1. Turn off the pump when the exhaust analyzer is not being used. This reduces the sensors exposure to 21% O_2.
2. Protect the sensor's water based electrolyte from freezing temperature (26°F).
3. Protect the sensor from contamination by properly maintaining the filter system.

MAINTENANCE SCHEDULE

To keep the TAS operating efficiently, follow the recommended service intervals listed on the maintenance schedule.

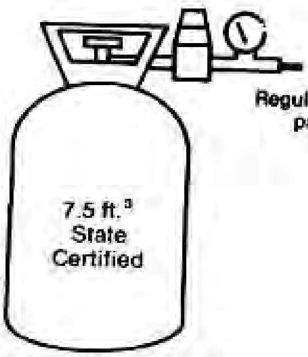
Routine Maintenance Schedule

COMPONENT	• INTERVAL	OPERATION
Air Inlet filter.	Weekly	* Clean or replace.
Primary sample filter.	36 hrs./200 or if low flow or HC hang-up indicated	* Replace. # Leak test/ hang-up test.
Secondary sample filter.	Monthly/1,000	* Clean or replace. # Leak test.
Sample hose and probe.	36 hrs./200 or if low flow or HC hang-up indicated.	* Clean or replace. # Leak test/hang-up test.
Bench outlet and water drain ports	Monthly/1,000	* Inspect.
Cabinet exterior, keyboard, vehicle harness	Monthly	* Clean.
Plexiglass window and Monitor screen.	Monthly	* Clean.
Tape recorder head.	Monthly/600 or each tape change.	* Clean.
Printer paper.	When red line on paper appears	* Change paper roll.
Infrared bench.	144-168 hrs. (6-7 days) or when prompted.	# Gas calibrate and leak test.

• Follow the maintenance interval (time, number of tests, etc.) that occurs first.
* See PTC Section 5-TAS Maintenance.
# See PTC Section 4-TAS Service Mode.

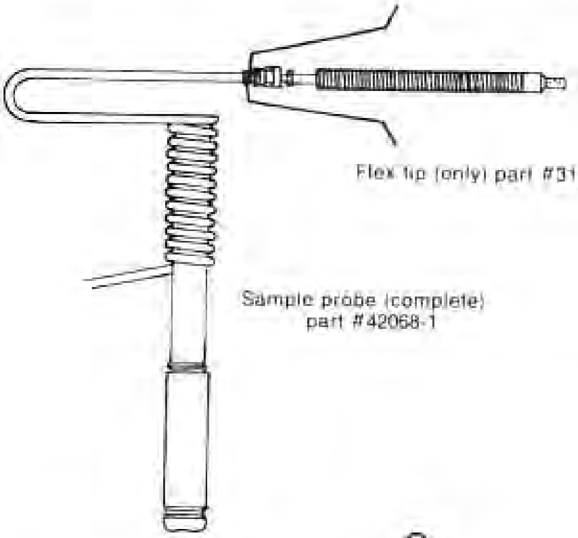
Allen Testproducts is pleased to provide this support information and is dedicated to keeping you a successful, satisfied user of our products. If you ever need assistance, contact your local Allen representative or office.

53-500 ACCESSORIES/REPLACEMENT PARTS



Regulator assembly part #42688

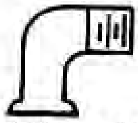
Calibration Gas part #42899



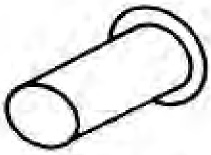
Flex tip (only) part #31544-2

Sample probe (complete) part #42068-1

Bungie cord part #41326
(2-required)

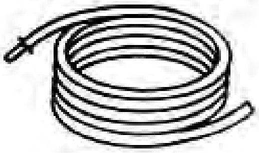


Street elbow part #28254



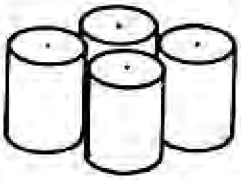
Probe cap part #41404

Hose (complete) part #42515

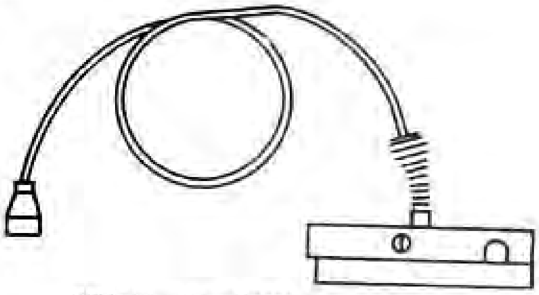


Hose (only) part #42074
Male quick disc. part. #42520
Clamp part #42072

Hose bracket part #43081



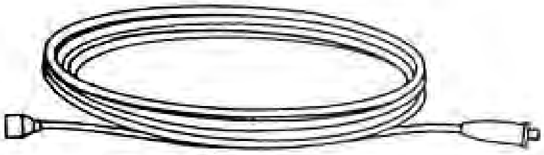
Printer paper (4 rolls) part #42901



RPM pickup part #40895-1

Data cassette part #43164

Needle probe part #42531



Remote Button part #42513

For Allen Sales Information Contact:

ALLEN INSTITUTE TRAINING PROGRAMS

Allen Testproducts currently offers technical programs designed to train the apprentice mechanic as well as challenge the accomplished technician.

These programs offer:

- System Operation.
- Diagnosis.
- Repairs and adjustments.
- Hands-on experience.
- Student evaluation.
- Certificate of achievement.
- Variety of training locations.

For further details:

- See program topics.
- Contact your local Allen Sales Representative.
- Call 616-345-8531 for information on the Allen training center nearest you.

Automotive Diagnostic Training —36 Hours

Topics:

- Cranking Systems.
- Charging Systems.
- Primary Ignition Systems.
- Secondary Ignition Systems.
- Emission Controls.
- Carburetion and Fuel Injection Systems.
- Infrared Exhaust Gas Analysis.

GM's Computer Command Control (CCC) — 16 Hours

Topics:

- CCC System Components.
- Air Management Systems.
- Electronic Spark Timing (EST)
- Idle Speed Controls.
- Torque Converter Clutch (TCC).
- Related Emission Controls.
- Carburetor Adjustments.
- CCC System Diagnostic Procedures.

Smog Testing and License Certification (Availability and Hours vary by state.)

Topics related to State Vehicle Inspection and Maintenance Programs.

- Program administration and requirements.
- Emission control systems.

Ford's EEC 1, 2, 3; MCU; Fuel and Ignition Systems—16 Hours

Topics:

- Ignition Systems (1974-1984).
- Electronic Engine Controls 1, 2, and 3.
- Microprocessor Control Unit.
- Variable Venturi Carburetor.

Chrysler's Closed Loop Carbureted Systems —16 Hours

Topics:

- Electronic Engine Controls.
- Ignition Systems (1972-1985).
- Electronic Spark and Fuel Controls.
- O_2 Feedback Systems.
- Idle Adjustment with Propane.

GM's Throttle Body Injection Systems — 16 Hours

Topics:

- Throttle Body.
- All Sensors and Controls.
- ECM.
- Electronic Spark Timing.
- Hall Effect Distributors

Future Training Programs

- Ford EEC 4.
- GM's Multi-Port Fuel Injection.
- Service Writing.
- Bosch Fuel Injection.
- Ford EEC 5.

For Allen Training Contact:

WARRANTY

Allen Testproducts Division of the Allen Group, Inc. ("Allen") warrants all equipment manufactured by it and delivered to the original purchaser to be free under normal use and service from defects in materials and workmanship for a period of one year from the date of delivery to the original using purchaser.

This warranty shall be fulfilled by the repair or replacement, at the option of Allen, of any defective part or parts, free of charge including labor, by the nearest Allen Authorized Repair Station.

This warranty shall not apply when failure is caused by the purchaser's misuse, abuse, neglect or by unauthorized alterations or repairs.

This warranty extends only to the original using purchaser and is not assignable or transferable either voluntarily or by operation of law.

This warranty applies only to equipment sold and used in the United States and Canada, although a similar warranty may apply on equipment sold for use in other countries.

A limited 90 day warranty shall apply to normal use items including test leads, harnesses, bulbs and fuses, probes and hoses, light pens and timing lights.

This warranty shall not apply to consumable items including filters, calibration gas and printer paper.

Allen reserves the right to make changes in design and/or improvements to its products without any obligation to include these changes in any products previously manufactured. Correction of defects by repair or replacement shall constitute fulfillment of all warranty obligations on the part of Allen.

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FOR WARRANTY SERVICE CALL 1-800-833-3377.

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Testproducts
Division
Kalamazoo, Michigan 49007 • Mississauga, Ontario

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